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Green Zia Environmental Excellence Program

Jewelry Manufacturing

Guidance for improved environmental performance and pollution prevention in your jewelry manufacturing business

Acknowledgements

The material in this booklet is based on the Systems Approach to Pollution Prevention, developed by Dr. Robert Pojasek of Pojasek and Associates and the Nothing to Waste Manual developed by US Environmental Protection Agency Region 1. Process maps were developed by Ms. Alicia Hale of Los Alamos National Laboratory. Special thanks also to Brynda Lujan of the City of Albuquerque for her assistance in preparing these maps.

This manual is printed on recycled paper. The manual jewelry manufacturing and distribution is supported through funding provided by the US Environmental Protection Agency. Special thanks to Rob Lawrence, Eli Martinez and Joy Campbell of the US Environmental Protection Agency for their help in funding this project and in supporting pollution prevention in New Mexico.

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The Green Zia Environmental Excellence Program

Guidance materials for jewelry manufacturing.

Introduction

This workbook contains information on how to establish a pollution prevention program specific for a jewelry manufacturing operation. The workbook also contains waste management and regulatory guidance materials to help assure that you are in compliance with environmental, health, and safety regulations. Used together, this information can help you establish a pollution prevention program that will help you be in compliance and reduce waste. Use of the tools from start to finish also helps you qualify for the Green Zia Environmental Excellence Program.

The Green Zia Environmental Excellence Program is a voluntary program based on quality management principles that is designed to help New Mexico businesses achieve environmental excellence through pollution prevention programs.. This program is administered by a partnership of state, local, and federal agencies, academia, private industry, and environmental advocacy groups. This packet has been specifically developed for a jewelry manufacturing operation and is designed to meet the needs of a small business.

The basic logic of the Green Zia Environmental Excellence Program is that:

- waste or pollution is the result of inefficiency;
- reducing waste increases profits;
- waste that is not created cannot pollute.

This guidance has been developed to aid in your company's understanding of best management practices to help your company comply with environmental health and safety regulations and to reduce waste and associated liabilities.

It is important to remember that environmental health and safety regulations are triggered by the use of equipment and chemicals. Better use of chemicals, use of safer chemicals, and efficient operation of machinery can help reduce your regulatory burden—if you aren't using hazardous materials, then you have fewer regulations to be concerned with! This program is based on first understanding work processes and materials use and then improving work practices to reduce cost, waste, and regulatory concerns.

Working through the Green Zia Environmental Excellence Program will result in a system that helps address environmental issues in cost effective ways, based on sound business practices. The system provides a framework for continuous improvement over time and contributes to a thorough understanding of environmental issues in your business.

What is Pollution Prevention?

Simply put, pollution prevention means not creating a waste in the first place. Pollution prevention is achieved by the efficient use of resources, including raw materials, energy, water and even time and distance. The goal is to produce a product or deliver a service as efficiently as possible, with the least amount of wasted materials and the least possible environmental impact.

The bottom line is that pollution prevention or improved efficiency can help businesses save money and help protect the environment at the same time.

What is Environmental Excellence?

Environmental excellence means moving beyond compliance with environmental, health and safety regulations by establishing an environmental management system that incorporates pollution prevention into core business practices.

A prevention-based environmental management system will:

- Help a business identify *all* the environmental compliance and health and safety concerns as well as costs associated with a waste generating process, and
- Use prevention approaches to reduce or eliminate the waste and reduce the associated costs.

In the Green Zia Environmental Excellence Program, attention is focused on the *process* that generates the waste, not the waste. Identifying and implementing process improvements will reduce waste and costs. This is a major shift from the traditional, reactionary approach that concentrates only on managing wastes or pollutants already created to an anticipatory approach that concentrates on prevention of wastes or pollutants to improve environmental and economic performance. This prevention-first environmental management system will identify cost effective ways to achieve "beyond compliance" status, creating a win-win situation between economics and environment.

The Green Zia Tools

The Green Zia Program provides tools to establish a basic prevention-based environmental management system. Management and employees walk through the tools as a team to gain a complete understanding of their operation. Examples have been worked out for the auto repair business. We encourage you to customize the examples to your own operations. The packet includes a series of process maps (Tool 1) for some operational areas of the auto repair business. Tools 2-6 are also explained and illustrated to help you develop your program. Use of these tools on a regular basis will help your company qualify for the Green Zia Environmental Excellence Program.

Green Zia Tools:

Knowledge of Process

Tool 1: Process Mapping: Illustrates the work steps materials pass through as they are transformed into your final product. Maps allow for the identification of all inputs and outputs such as water, chemicals, electricity or other materials from a process, helping you to understand wastes and their sources. Maps also help you understand regulated activities.

Full Cost Accounting

Tool 2: Activity-Based Costing: Identifies the true costs of wastes or losses and helps participants identify areas to target for pollution prevention, by assigning dollar values to these wastes and losses.

Pinpointing Problems

Tool 3: Root Cause Analysis: Creates a cause and effect diagram to highlight why and where the losses occur in the process. Understanding why and where the loss occurs will help participants focus on specific areas for improvement.

Problem Solving

Tool 4: Brainwriting: Addresses problems by generating as many alternatives as possible to minimize loss.

Prioritization of Options

Tool 5: Bubble-up-bubble-down: Ranks alternatives to determine the optimal solution. Factors such as cost, ease of implementation and effectiveness are considered in evaluating and ranking the alternatives.

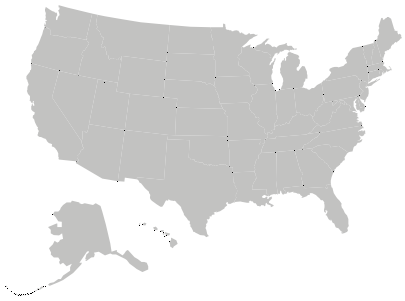
Ensuring Success

Tool 6: Action Plan: Details each step that needs to be taken to implement the alternative and reduce or eliminate the loss from the process.

Tool #1: Process Mapping

To begin incorporating pollution prevention into your business, you must first get a full understanding of where wastes are being generated. This tutorial will discuss the advantages of using process maps to logically evaluate each step of your process.

Warm-up Exercise



Maps have been used throughout the ages for many purposes from helping sailors navigate the seas to providing a safe route for climbers hiking to the tallest peaks. You have probably drawn maps to your home or office so that someone could visit. It is important that the information on this map is complete and accurate or, as you may have found, your guest will get lost!

Take a minute now and think of a coffee shop or restaurant nearby that everyone in the group knows. Draw a map from the building you are currently in to this establishment - include traffic lights, landmarks, and any other important features along the way. Now compare maps with the other members of your group. Are they the same? If a person not familiar with the area were to use your map, would they have found their way?

Introduction

Are you aware of the amount of waste that your business generates? Could this waste be turned into profit? By considering methods of reducing wastes, recycling used and unused raw materials, and reusing lost material, you could not only help the environment but also reduce your raw material and waste disposal costs.

This section discusses process mapping, a method of analyzing a process in order to catalogue all the materials used and lost in the process. With process mapping, you will systematically identify the series of steps materials pass through as they are transformed into the final product. Evaluating your process in this manner will allow you to recognize the opportunities to prevent losses and possibly streamline operations. Each loss identified during the process mapping is an opportunity to prevent that loss.

A series of process maps have been developed for jewelry manufacturing operations and are included in this packet. You should customize these maps for your operation, since no two businesses are exactly alike. These maps become a reference for you to use for your pollution prevention program and can be updated to reflect changes as you improve your operations. These maps are also great for training new employees and for other problem solving needs.

Large businesses and manufacturers use these tools to understand and improve their manufacturing processes. Small businesses can benefit by using these tools as well!

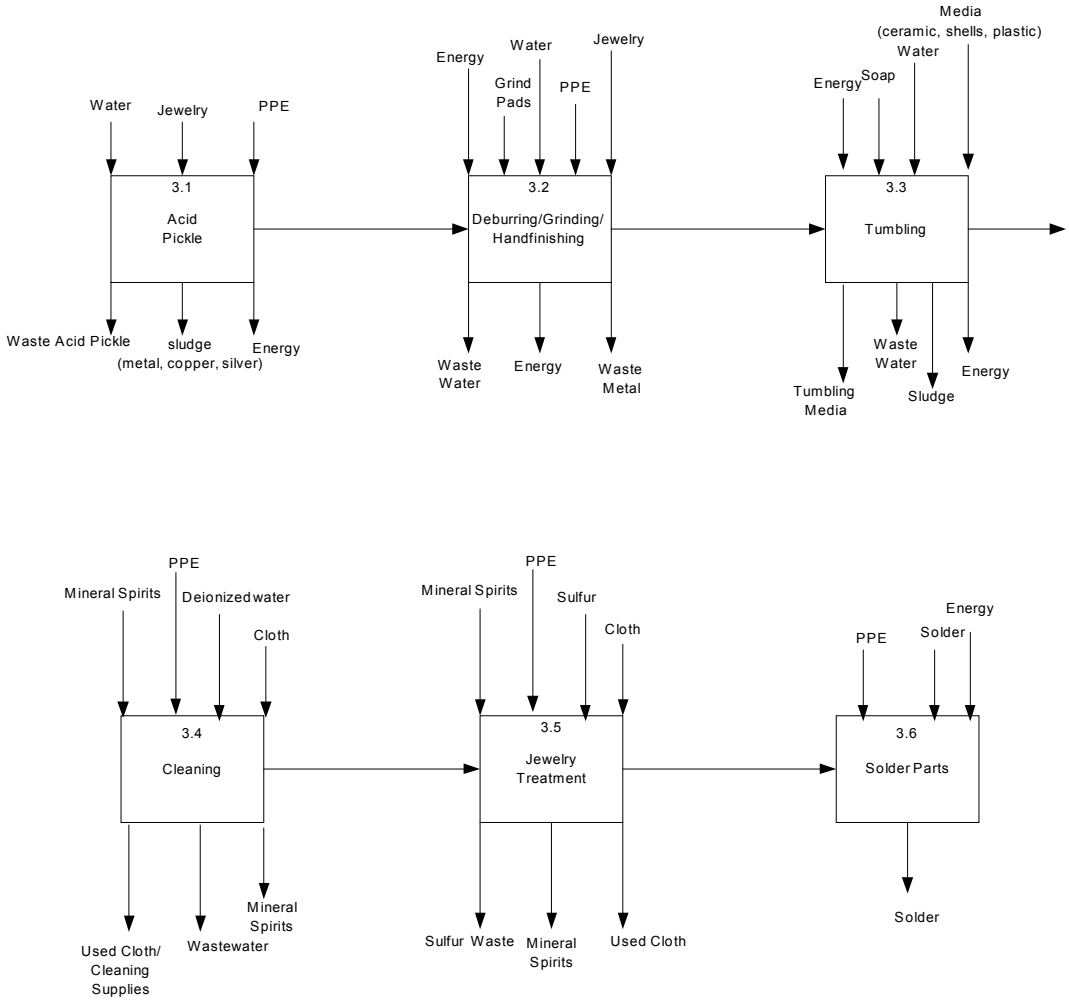
It is helpful to also prepare a narrative to go along with your process maps to explain the process in detail. We recommend that you include regulatory activities in the narratives as part of your environmental management system. Narratives are also included in this packet; please revise to reflect your business operations.

Create a team of employees to complete this exercise. During this exercise you will:

- Examine and revise the process maps and narratives in the packet to accurately reflect your operation
- Fully understand the functionality of each step of a process
- Identify the inputs and outputs/losses within the process
- Communicate findings in a clear and concise manner to members of the team.

Example of a process map for jewelry manufacturing:

Process Map 3.0: Jewelry Finishing



Please review the process maps in the back of this booklet and make changes to reflect your operation.

Once you have reviewed and revised the process maps to your operation, move to the next section…Activity-Based Costing!

Tool #2: Activity-Based Costing

Every waste or environmental loss costs you money. By determining the activities that cause waste, you can focus your pollution prevention efforts to minimize the cost to your business and protect the environment. This tutorial will introduce you to a method of evaluating your waste.

Warm-up Exercise

Your daughter approaches you one evening and says that she is planning to buy a car. With the $400 she has left over each month, after paying all of her bills, she is sure she will be able to afford the $220 monthly car payment.

What are the other costs of operating and maintaining a car that she is forgetting? Consider not only the annual costs, such as insurance, but also the intermittent (once in a while) costs. Can she really afford this car?

Introduction

Once you have determined the losses in your processes through your process maps, you can discover how these losses are affecting your "bottom line". How much does it cost you to discard 10% of your raw materials, or 2% of your finished products? Which activities have losses that most hurt the profitability of your company? This tool will help you look at the cost of the losses in your business and see how much these losses are costing you. The results may surprise you!

Which losses should you care about? The Pareto Principle suggests that 80% of the problems in a business come from 20% of machines, raw materials or operators. (The same is true for any facet of a business, for example, 80% of sales come from 20% of your customers, etc.) Once you have assigned costs to your activities, you can figure out which 20% of your activities are contributing to 80% of your costs. The Pareto Principle is very important in activity-based costing as it is used to focus on the most important areas for improvement in your pollution prevention program. Use of the Pareto Principle for the activity-based costing section will help you quickly identify areas of your business to focus your prevention efforts.

New Terms

Activity based costing (ABC) - An accounting method used to assign the cost of your losses to the activities that generate these losses. By assigning costs to activities, you will discover the activities should be targeted for prevention.

Environmental costs -The costs associated with the losses in your process.

Intermittent or support operations – Operations that occur once in a while that are necessary for the key processes to operate.

Pareto principle - A principle that suggests that 80% of anything can be attributed to 20% of the factors involved. For example, 80% of your environmental costs can be attributed to 20% of your activities.

Activity-Based Costing

1. Make a list of all the activities in your operation. Be sure to include the activities from your process map as well as any intermittent operations (such as cleaning or maintaining equipment.).

2. Regular activities:

    a. Designing jewelry
    b. Making molds
    c. Making casts
    d. Melting/pouring metals
    e. Devesting materials
    f. Finishing Jewelry
    g. Packaging and shippibg

3. Support activities:

    a. Managing pickling solution
    b. Managing devestment wastes
    c. Equipment maintenance
    d. Managing cleaning wastes
    e. Managing various wastes such as molds, waste metals, wastewater
    f. Equipment maintenance

4. List all of the losses in your operation. Look on your process map and add any others that you think of.

5. Reviewing your process maps, identify the operations in your plant that generate most of your waste or pollution problems. For example, does cleaning solvent use cause most of your environmental problems? Do pickle wastes or air emissions from baking flasks or melting metals result in your biggest environmental problem? Does the 80/20 Rule apply? Focus your efforts for now on the areas of your operations that you do the most or that create the biggest environmental problem for you.

6. Use process maps to review material use and losses for your selected process or operation. You will use these maps as a guide to assign costs to these losses.

7. Identify which major costs or general ledger costs apply to the material use and losses on the process maps (utilities, metal purchase costs, waste disposal costs, costs that are easy to get information on and that you typically consider when looking at your processes). Enter into Table 1. (See example provided)

8. Identify which other activities are related to the use of these materials that are not in the major costs (protective equipment such as gloves or goggles, monitoring, record keeping, maintenance, permits, metal recycling services, waste management service contracts, fees to the state or city, storage space for chemicals, the cost of spill clean-up and reporting). These activities are not usually considered when thinking about the cost of a process, yet the costs associated with them can be significant.

9. Write the activities in the first column of Table 2. Along the top list all the costs or services required for these activities. Add or delete categories as appropriate for your business. Put an "x" for every cell that applies.

10. Count the total number of "x's" in Table 2. Then circle the x's that represent what you estimate to be about the top 20% of the most expensive activities in your operation. Again, you are using the 80/20 rule: 20 percent of your activities will probably add up to about 80% of your total costs.

11. Then estimate only the cost of each of these top 20% of activities that you circled and write them in a new table. Cost estimates are allowable as you are using this method to prioritize your most expensive activities. You can refine costs once you have chosen a project to work on. (In the example, the top 20% of the cost categories chosen have the estimate beside them.) Add these numbers into Table 1 under the appropriate waste stream in the "Hidden costs" line.

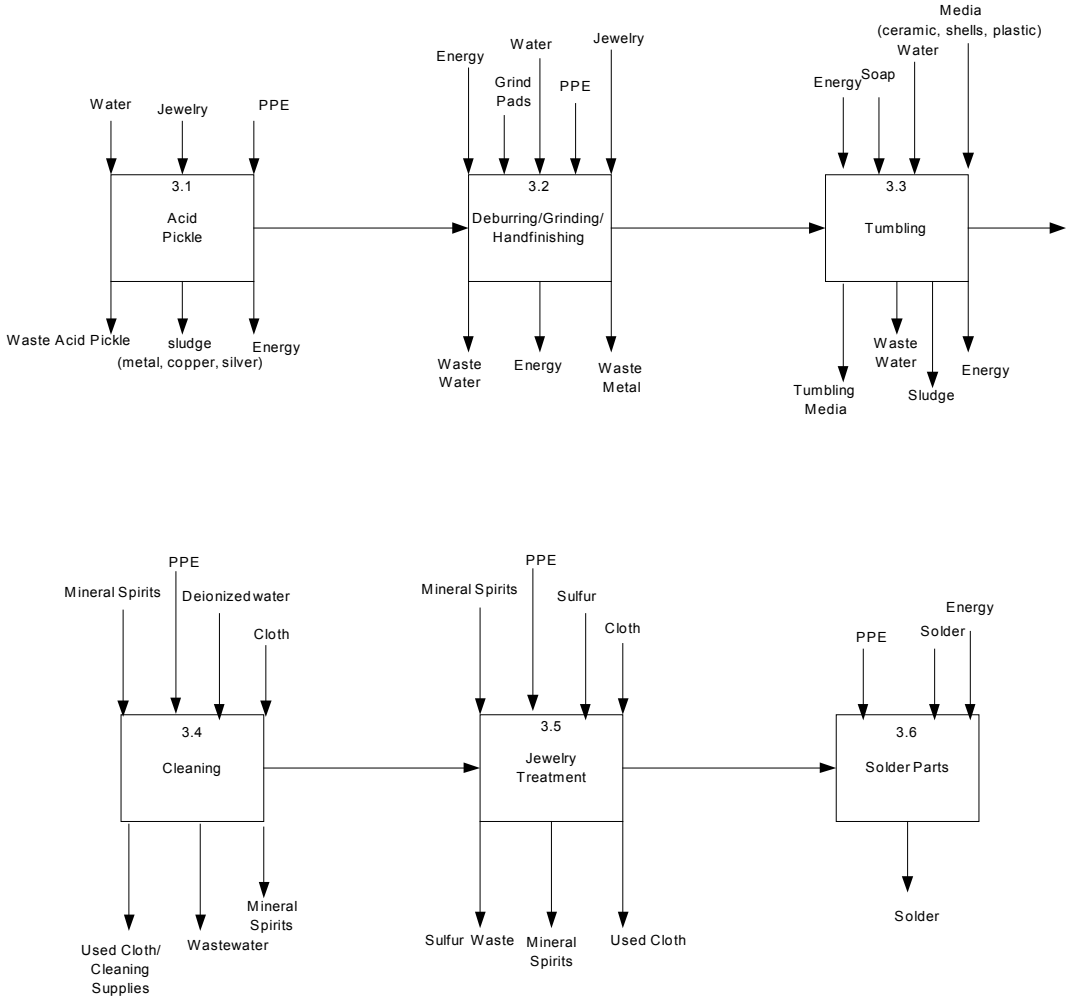
12. Add the ledger costs and the hidden costs together to discover the true costs.

13. Create a Pareto Chart. Create a chart showing all these costs graphically. On the x axis (vertical), place costs in dollars, on the y axis (horizontal), show the true costs of the wastes. This chart will help graphically show how all the costs stack up against each other. Does the 80/20 Rule apply here? Use this chart to identify the most expensive processes. This can be used to identify the first area for improvement. Which waste stream do you think you should focus on from this Pareto chart?

An example of Activity-Based Costing is provided in the next section. Please note that this is an example to demonstrate how to assess costs. The costs included are not from an actual case study. Water and energy costs are not included in this example but should be considered in developing improvement and cost saving projects. The example provided addresses only the major processes in a jewelry manufacturing operation. Environmental improvement can be applied to every waste generating activity in your operation!

Activity-Based Costing Example

Process Map 3.0: Jewelry Finishing



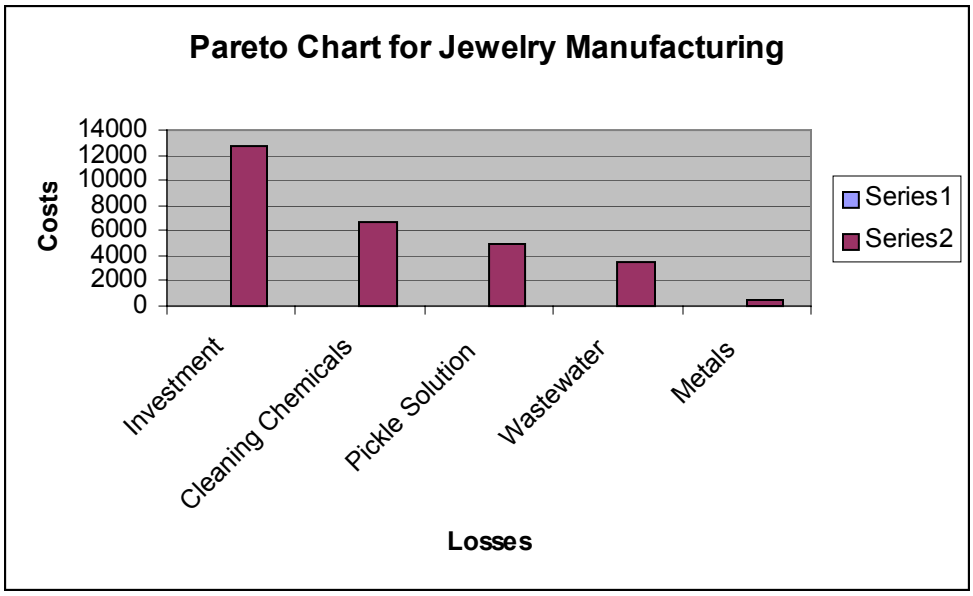
Activities	Materials and Losses
Acid Pickling Deburring Tumbling Treatment Soldering	Wastewater *Spent Pickle Solution *Energy (major cost across organization) *Metals *Waste Cleaning Solutions Devestment Waste *Paper (*) indicates most important waste streams and materials

Table 1. Activity-Based Costing Analysis (Per year)

Workstep						
Costs/Losses	Pickle Solution	Cleaning Chemicals	Investment materials	Waste-water	Metals	Total
Raw material	$2,000	$500	$2,500	$1,500	$2,500	$12,000
Disposal fees	$2,500	$1,500	$3,500	$2,0000	0	$13,500
Other ledger costs	$500					
Hidden Costs	**($2,000)**	**($4,650)**	**($6,650)**	**($500)**	**$2,000**	**($11,300)**
Total	**$5,000**	**$6,650**	**$12,650**	**$3,500**	**$500**	**$28,300**
%of Total	.18	.240	.45	.12	.08	1.0

Table 2. Hidden Cost Analysis (per year)

Pickle Solution					
Activities/Cost Factors	Materials	Space	Utilities	Services	Labor and or fee costs
HW Gen. fees					X ($1,000)
Reporting					x
Pickle Recovery Unit	X ($1,000)	x	x		x
Total hidden costs for pickle solution					***($2,000)***
Cleaning Chemicals					
Record keeping					x
HW Gen. fees					X ($1,650)
Recycling services	x	x		X ($3,000)	
Cleaning equip.	x			x	x
Total hidden costs for cleaning chemicals					***($4,650)***
Investment Materials					
Discharge fees					X ($1,650)
Handling	x	x	x	x	X ($5,000)
Water use fees					x
Total hidden costs for investment materials					***($6,650)***
Wastewater					
Discharge fees				x	X ($500)
Total hidden costs for wastewater					***($500)***
Metals					
Recovery service				X $3,500	X ($1,500)
Total hidden costs for metals					***$2,000***



Pareto Chart for Jewelry Manufacturing. The Pareto Chart illustrates costs relative to each other and helps choose areas to target for pollution prevention activities. In this example, investment materials, the most expensive loss, will be the focus of the pollution prevention efforts in the following sections.

Now that the process mapping and activity-based costing are completed, you have a sense of the relative environmental costs of your operations. Since investment materials are the target, we will use the following problem-solving and decision-making tools to find a way to reduce investment use, increase efficiency and save money.

Most of your work is done. These two tools can be revised as needed. Use these maps and information annually (or more often!) to keep improving your operation on an ongoing basis. Now that you have identified your most expensive wastes, you can now move towards solving problems and eliminating waste…the next tool is Root Cause Analysis!

Table 1. Activity-Based Costing Analysis (Per year)

Workstep							
Costs/Losses							Total
Labor							
Raw material							
Disposal fees							
Other ledger costs							
Hidden Costs							
Total							
%of Total							

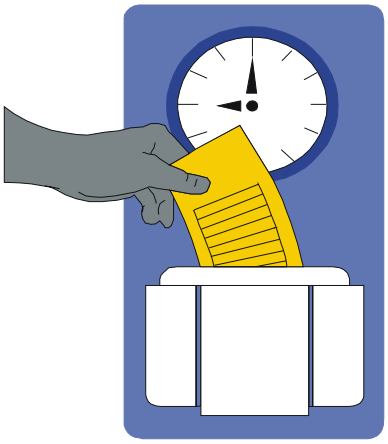
Table 2. Hidden Cost Analysis (per year)

Activities/Cost Factors	Materials	Space	Utilities	Services	Labor
Waste Stream					
Monitoring					
Reporting					
Repairs					
Recycling disposal service					
Spill clean-up					
Storage					
Record keeping					
Generator fees					
Total hidden costs for (waste stream)					
Waste Stream					
Monitoring					
Reporting					
Repairs					
Recycling disposal service					
Spill clean-up					
Storage					
Record keeping					
Generator fees					
Total hidden costs for (waste stream)					
Waste Stream					
Monitoring					
Reporting					
Repairs					
Recycling disposal service					
Spill clean-up					
Storage					
Record keeping					
Generator fees					
Total hidden costs for (waste stream)					

Tool #3: Root Cause Analysis

Now that you have recognized the activities in your process that are costly or expensive to your business, you can begin to focus your efforts on pollution prevention. This tool presents a method of detecting the underlying reason for an environmental loss so that the loss can be prevented.

Warm-up Exercise



Think of all of the times that you have been late for work and list the different reasons for your delay. Maybe your alarm clock did not go off, or perhaps your child was sick and you needed to arrange for a sitter. Did you spend too much time reading the newspaper or did you need to run to the store to pick up milk.

Arrange all these reasons in the categories listed below, or create an additional category. Some of the items on your list may be entered more than once. Now consider the last time you were late for work. Why were you late? Circle the reason.

MACHINES
broken alarm clock

PEOPLE
sick child

METHODS
reading the newspaper

MATERIALS
out of milk

Introduction

In the last tool you determined the key losses responsible for the greatest amount of environmental costs. In order to try to prevent a loss, you must first understand why it is occurring. The underlying reason for a loss is also known as its "root cause". The root cause will answer the question: What *ultimately* caused the loss? Determining the root cause of an environmental loss is very similar to determining the root cause of being late for work

A cause and effect diagram is one method of determining the root cause for a loss. This tool provides a visual description of all possible causes for a specific loss. Once all the possible causes are depicted on the diagram, the most plausible cause or causes are identified. It is imperative that all persons involved in determining the root cause are in agreement. The next step is to write a "Dear Abby" letter summarizing the cause or causes for a loss will ensure that all participants see the problem in the same way.

During this exercise you will:

- Construct a cause and effect diagram with all potential causes for a loss.
- Discuss the most probable cause or causes.
- Write a Dear Abby letter describing the reason for the loss.

Root Cause Analysis

After participating in process mapping and activity based costing exercises, it was determined that the largest loss, investment materials, accounts for approximately 80% of all environmental costs in the jewelry manufacturing operation. The next step is to discover the root cause of this loss.

To determine the root cause of a loss, you must ask, "Why is the loss occurring?" One way of gathering information concerning the generation of a loss is called a cause and effect diagram, or fish bone diagram, since it resembles a fish bone. Major categories of possible causes for the loss are first defined and entered on the diagram as an offshoot from a main horizontal line. Next, all possible causes of the waste are assigned to a category and entered on the diagram. Once all the causes are defined, an agreement is made as to the most plausible reason for the loss.

Divide the causes into four major categories - Methods, Machines, Materials, and People - and then write down all the possible reasons why investment materials could be lost from the process and assign them to a category. Begin the diagram and then write down some of the things that immediately come to mind. An example has been provided in Figure 2.

Several things may come to mind. Investment is used for each piece of jewelry that is processed. People may not fully utilize the wax trees and less jewelry is made per flask and investment materials. Spills may occur often. Investment may not be mixed right and could cause failure. Also people operating the various mold and jewelry making processes are critical and training and a good work attitude are critical to efficient operations. All of these ideas should be entered under one of the four categories in the fishbone diagram: Machines, Methods, Materials and People as in the example in Figure 2.

Now that all the possible causes investment being lost during the jewelry manufacturing process are categorized, it is time to determine the most probable cause. Go back to the diagram and circle the most probable causes. One of these should be the root cause**.** Then, working with employees as a team, discuss which one of these major causes is the root cause. To come to clear understanding of the root cause, we suggest that the team write a short "Dear Abby" letter describing his or her interpretation of the problem to ensure that each person sees the problem the same way. Once the letter is in place, the group becomes Abby and seeks to solve the problem. *(see Figure 3)*

Another method for determining the root cause of a problem is the "5 whys".

By asking the question "why?" five times, you may get to the root cause of a problem. An example of how the five whys works is as follows.

The Five Whys:

1. Why has the machine stopped forcing an interruption in production?
   A circuit breaker tripped due to an overload.
2. Why was there an overload?
   There was not enough lubrication for the bearings.
3. Why was there too little lubrication for the bearings?
   The pump was not pumping enough lubrication.
4. Why was there not enough lubricant being pumped?
   The pump shaft was vibrating because of abrasion
5. Why was there abrasion?
   There was no filter, which allowed chips of metal to get into the pump.

The solution is then to place a filter on the pump to capture metal chips.

Both tools can be used to find the root cause of the problem. For most problems to be permanently solved the root cause must be addressed. The fishbone diagram is a good visual tool that helps you understand all the areas that contribute to a problem. Understanding all the contributing factors will help facilitate problem solving. The Five Whys will also help you move past dealing with the symptoms of the problem to solving the real problem.

Examples of the fishbone diagram and a Dear Abby letter are included as well as a blank fishbone diagram for your use.

The next tool will present brainwriting - a method to generate ideas.

Figure 1: Jewelry manufacturing Process - Process Map

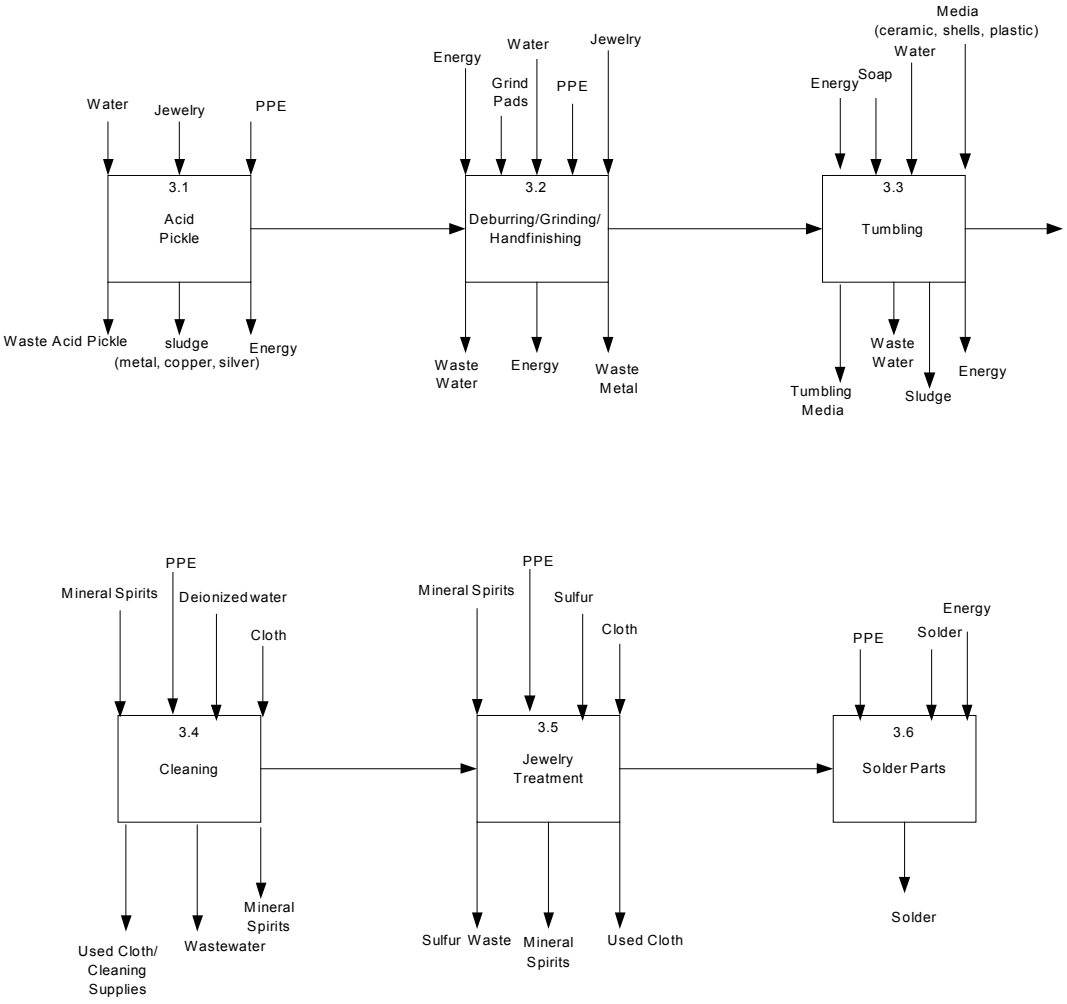


Figure 2: Cause and Effect Diagram

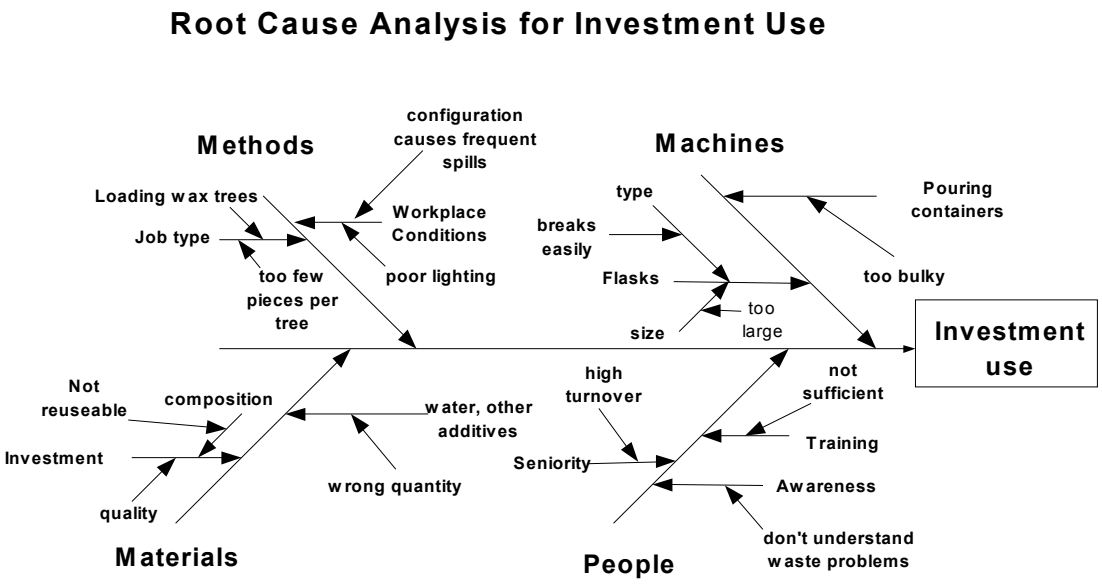


Figure 3: Dear Abby Letter

Dear Abby,

We run a small jewelry manufacturing operation. Investment use and disposal is our most expensive business issue. We use lots of investment materials that must be managed as a solid waste. That means that lots of materials must be thrown in the dumpster. Our solid waste fees are outrageous and it seems bad to be sending so much material to the landfill. These are issues that we wish to take seriously.

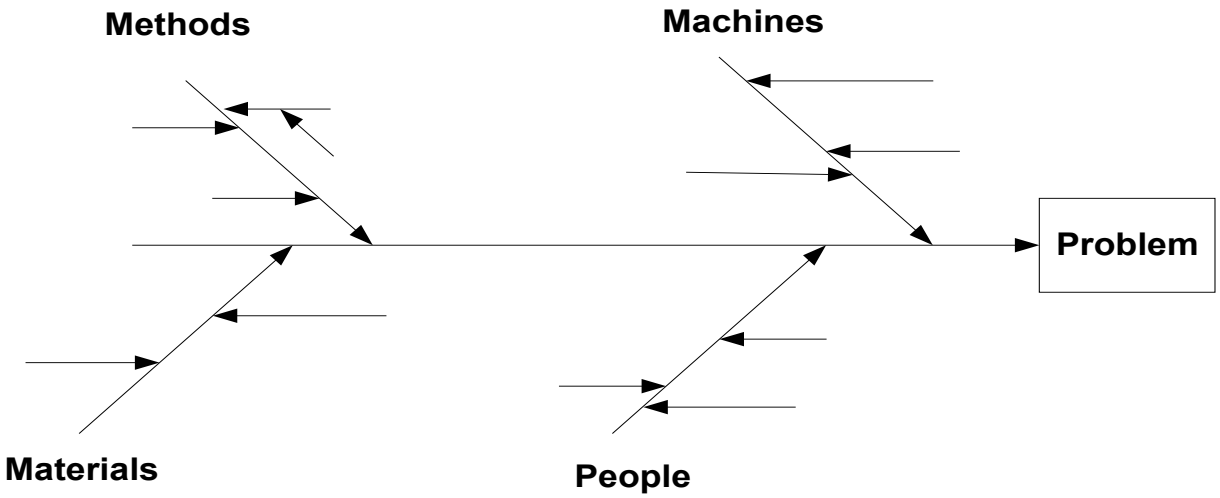
Our root cause analysis revealed that the root cause of investment use is how we load wax trees in the flasks. Much investment is lost through defects, damaged trees and under-utilized flask use. Also, employees tend to create lots of spills and reject materials due to poor investment mixing and flask filling.

Can you help us?

Signed,

Invested in Albuquerque

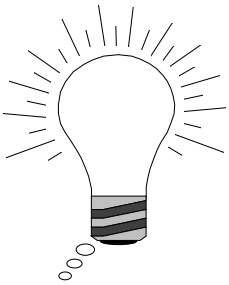
Figure 4. Root cause analysis: Fishbone Diagram



Tool #4: Brainwriting

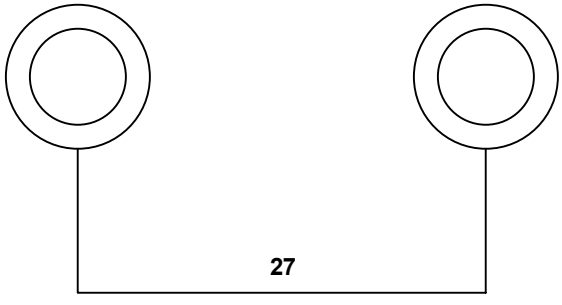
To address an opportunity effectively, it is important to recognize all alternatives. Very rarely is there one "right" way of preventing pollution. Instead, there are many different potential solutions. This tutorial presents a technique of listing many different alternatives for an opportunity.

Warm-up Exercise



You know the old adage "two heads are better than one". This is especially true when trying to come up with new ideas. When you generate ideas in a group you will notice that each member of the group brings their unique set of experiences and strengths to the table.

Try the following exercise with your group. Look at the picture below (turn it on it's side and upside-down). What does it remind you of? Write down all the images that come to mind- even images that seem crazy should be included. Now go around the room, each person sharing one image with the group. One person should volunteer to keep a list of all the images. Repeat this step until every member of the group is out of images. How many images did the group come up with? How does this compare with the number of images you generated alone?



Introduction

In the last tool you evaluated all the probable causes of a loss and determined the underlying reason, or root cause. Once the root cause has been identified, you may be tempted to jump to a premature solution. When you address a loss without considering all the alternatives of prevention you may be overlooking the most appropriate option(s).

Looking for alternatives for pollution prevention by addressing its root cause is the next step towards addressing an opportunity. There are several tools available to help groups develop alternatives. You already explored one tool during the warm-up exercise. In this exercise you will explore another method-brainwriting. Brainwriting requires maximum interaction and creativity between group members. The group should consider all possible alternatives, regardless of how far-fetched they appear to be. Alternatives raised by the group may seem contradictory, or they may build on one another making them better. A comprehensive list of alternatives can then be compiled.

During this exercise you will:

- Conduct a brainwriting session.
- Develop a list of all possible alternatives for an opportunity for improvement.

Brainwriting

First you have completed your process map to see how you can optimize your processes and reduce losses. *(see Figure 1)* In the example provided, Activity-Based Costing helped to identify that 80% of the environmental costs associated with jewelry manufacturing was due to investment use. Not only is investment expensive, it is critical to the process and we use large quantities of this material on a daily basis.

Root cause analysis determined that the greatest losses occurred due to employee handling practices. Employees control the jewelry manufacturing processes from the beginning to the end and also must deal with environmental, health and safety compliance issues.

The next step is to develop as many alternatives to solve the problem as possible. This is done through the process of brainwriting. Through brainwriting, staff works together to generate as many alternatives as possible regardless of how crazy they seem. In fact, to make it more

interesting you can give a prize to the person that comes up with the craziest idea.

Make copies of the blank brainwriting sheet included at the end of this chapter. Make enough sheets so that each person on the brainwriting team has one per person with one blank sheet in the middle of the table. Place these sheets in the center of the table. Each person should take a sheet and write two alternatives on it and then place the sheet back in the center. Then take another sheet of paper and write two more alternatives on it. Every time someone picks up a sheet of paper, encourage them to read what others have written and try to make improvements to the alternatives listed. Someone could even say they think someone's idea is completely out in left field, if they try to make it better. Keep repeating this process until everyone runs out of ideas.

Now list all the alternatives that were discovered.

The alternatives on each sheet of paper should be read aloud and discussed. Many of the ideas may be the same and some may have small variations. The group should debate the small variations and eliminated the impossible alternatives. One comprehensive list should be developed- each idea only written once, although all variations of the same idea should be included.

Examples of brainwriting are provided below.

The next tool will present 'bubble-up-bubble-down"…a method for selecting the best option to prevent loss.

Figure 1: Jewelry manufacturing Process Map

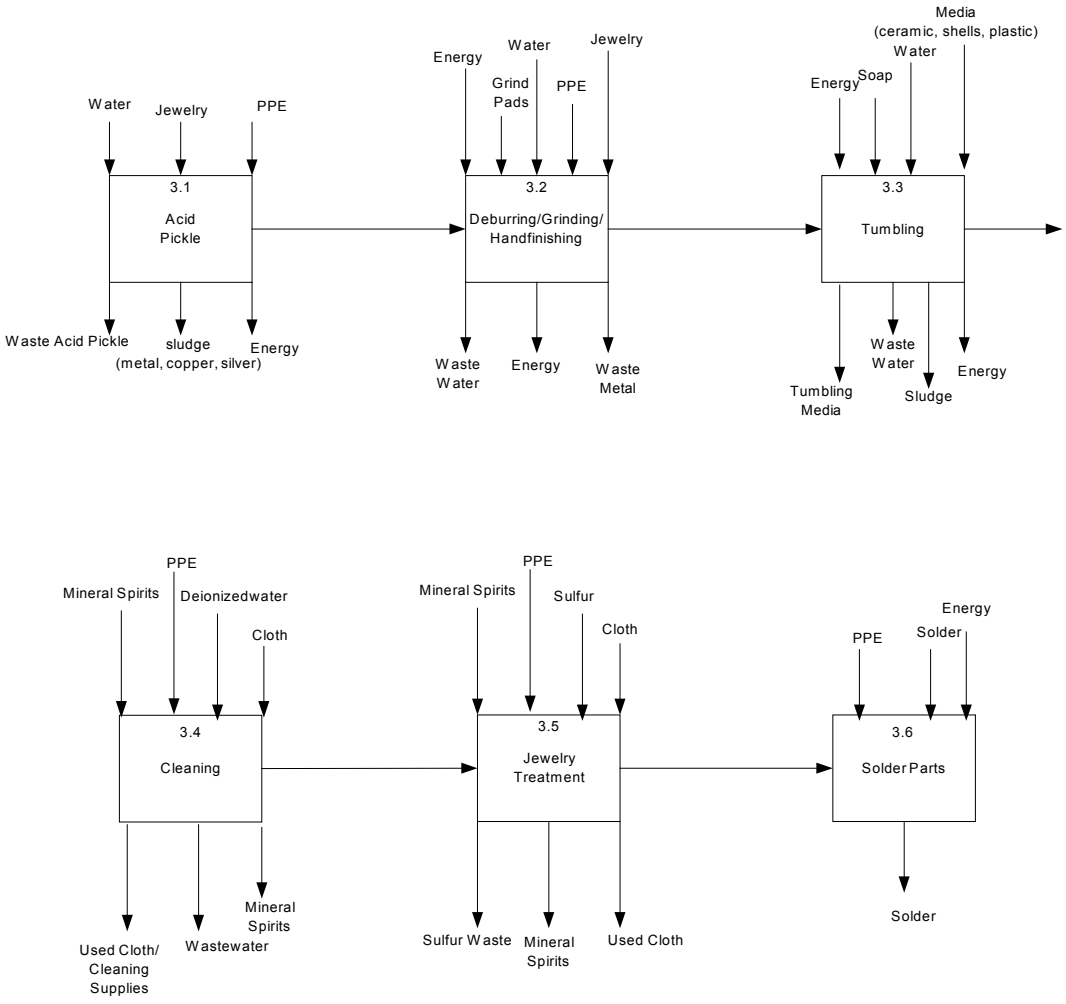


Figure 2: Sample of brainwriting

1. Look for reusable investment to eliminate all environmental problems.	2. Find a market for waste investment.
3. Set up work area more efficiently to reduce carry distances for flasks to save time and prevent dropping, etc.	4. Develop alternative flask design that uses less investment.
5. Start a "clean shop" program to train employees to keep work areas clean to prevent spills and waste.	6. Begin an employee incentive program to reward development of best operating practices that reduce loss from rejects and excessive investment use.
7. Utilize flasks more effectively to get as much jewelry as possible per flask.	8. Develop Standard Operating Practices for mixing investment to prevent rejects and failure.
9.	10.

Figure 3: List of alternatives

1. Look for reusable investment to eliminate all environmental problems.
2. Find a market for waste investment.
3. Set up work area more efficiently to reduce carry distances for flasks to save time and prevent dropping, etc.
4. Develop alternative flask design that uses less investment.
5. Start a “clean shop” program to train employees to keep work areas clean to prevent spills and waste.
6. Begin an employee incentive program to reward development of best operating practices that reduce loss from rejects and excessive investment use.
7. Utilize flasks more effectively to get as much jewelry as possible per flask.
8. Develop Standard Operating Practices for mixing investment to prevent rejects and failure.

Figure 4: Brainwriting Sheet

1.	2.
3.	4.
5.	6.
7.	8.
9.	10.

Tool #5: Bubble Up-Bubble Down

You have now generated a list of alternatives for preventing an environmental loss in your business. But how do you choose the best alternative? This tutorial presents one method of prioritizing alternatives to ensure that the most appropriate alternative is selected.

Warm-up Exercise

Most of us use lists from time to time to make sure that we don't forget to do the things that we need to get done. Without a shopping list, for example, we may return from the store without milk, the reason why we went in the first place. Certain limitations, like time or money, may cause us to drop things off our list. We often need to prioritize and make sure that the most important things get done.

Make a list of the things that you need to get done tomorrow (try to list at least ten things). List these items in the order that they come to mind. Now prioritize this list by putting the most important items on the top of the list and the least important items on the bottom. You should now have a "rank ordered" list. If you only have time to complete one of the items on your list, which would it be? You should have answered the item on the top of the list the most important item.

Introduction

A comprehensive list of pollution prevention alternatives was developed in the last tool using a technique called brainwriting. The alternatives generated during this tutorial can range from operational changes, such as employee training and improvements in operations, to technology changes, such as changing a solvent. The next step is to choose one alternative that is capable of being worked with successfully. Additionally, it is important to select the optimal solution for your business. To accomplish this, you must consider the *feasibility* of each alternative. Such factors as effectiveness, implementability, cost, and potential ramifications of each alternative should be discussed. Personal preferences and biased information should not enter into the decision-making process.

There are several tools available to aid a group in selecting an alternative and avoid bias. These tools allow a group to rank and prioritize alternatives using a systematic approach. When all the alternatives are listed, suggestions are made by the group to improve even the worst alternatives. At this point, many of the alternatives may be eliminated: every realistic alternative remains on the list. These remaining alternatives can then be sorted based on the factors presented above and any other factors that may effect a particular business. The method of selection presented in the exercise is the bubble-up-bubble-down. This tool uses a forced pair comparison to rank alternatives. Using this method you will be able to find the most effective solution to the selected loss.

During this exercise you will:

- Evaluate all alternatives.
- Use the bubble-up-bubble-down method to reach a decision on the best alternative.

Bubble-Up, Bubble-Down

Take the list of alternatives and compare the first two alternatives. Decide which of the two is the best and move this alternative to the top of the list. Go to the next, or third alternative and compare it to the second. If it is better than the second, move it up and compare it to the first, if not, leave it in the third position. Continue this process until all the alternatives are rank ordered. This process should go fairly quickly. Make sure you listen to everyone's opinions and objections. Again, factors to consider are cost, effectiveness and the ability to implement the alternative.

Bubble-up, Bubble-down should generate much discussion among employees on the best solutions. These discussions will help to increase buy-in to the alternatives. As a rule, employees never resist their own ideas.

An example of how the Bubble-Up Bubble-Down method was applied to the list of alternatives generated in the last tool are listed below.

Typically, the three or four alternatives that "bubbled-up" to the top of the list are the easiest and cheapest to implement, the "low-hanging fruit". The alternatives in the middle may require more research or study to see if they are feasible. The ideas at the bottom of the list may require major equipment changes or capital investments. It is important to keep the entire list on file as part of your continuous environmental improvement program.

The next step is to develop an action plan. Action planning is essential to assure that ideas are implemented!

Figure 2: List of alternatives, prioritized through Bubble-Up, Bubble-Down

1. Begin an employee incentive program to reward development of best operating practices that reduce loss from rejects and excessive investment use.
2. Utilize flasks more effectively to get as much jewelry as possible per flask.
3. Start a “clean shop” program to train employees to keep work areas clean to prevent spills and waste.
4. Develop Standard Operating Practices for mixing investment to prevent rejects and failure.
5. Set up work area more efficiently to reduce carry distances for flasks to save time and prevent dropping, etc.
6. Develop alternative flask design that uses less investment.
7. Find a market for waste investment.
8. Look for reusable investment to eliminate all environmental problems.

Tool #6: Action Planning

Being able to successfully manage a project is important when trying to accomplish a task, especially when you are under a deadline. You need to set up a schedule, ensure that you have the necessary resources, and assign the right person to each part of the job. In this tutorial you will create an "action plan" for the implementation of an alternative to prevent pollution.

Warm-up Exercise

Your group has been assigned the task of making chocolate chip cookies. The cookies need to be ready in one hour and the cooking time is twelve minutes. Pick a person to manage this project. The manager must then assign the ten tasks listed below to individuals in the group.

You will need to know how much time is required for each task, what tasks need to be accomplished before others, what resources (i.e. bowls, flour etc.) are required, and what the most efficient way of organizing these tasks (and remember the clock is ticking). Create a schedule.

Making chocolate-chip cookies:

Mix dry ingredients
Mix wet ingredients
Put the batter on the pan and put pan into the oven
Combining wet and dry ingredients
Turn on the oven
Taste cookies
Wash tools and utensils
Grease pan
Take cookies out of the oven

Developing an Action Plan

Before you begin to implement your alternative you should complete this questionnaire. It will ensure that you are being thorough in your planning and have considered all the important issues that may arise such as the resources that are needed and the problems that may occur. *(see Figure 2)*

Things to consider in developing an action plan are resources needed, both financial and human resources; the need for pilot testing or bench scale testing; information sources from he outside such as trade associations, vendors and suppliers and the Environment Department. Other issues such as employee support and maintaining product or service quality should be considered. A list of questions that should be considered during action planning is as follows:

Action Planning Questionnaire

1. What is the overall objective and ideal situation?
2. What steps are needed to get there from here?
3. What actions need to be done?
4. Who will be responsible for each action?
5. What is the best sequence of action?
6. How long will each step take and when should it be done?
7. How can we be sure that earlier steps will be done in time for later steps that depend on them?
8. What training is required to ensure that all staff have sufficient know-how to execute each step in the plan?
9. What standards do you want to set?
10. What volume or quality is desirable?
11. What resources are needed and how will you get them?
12. How will you measure results?
13. How will you follow up each step and who will do it?
14. What checkpoints and milestones should be established?
15. What are the make/break vital steps and how can you ensure they succeed?
16. What could go wrong and how will you get around it?
17. Who will this plan affect and how will it affect them?
18. How can the plan be adjusted without jeopardizing its results for the best response and impact?
19. How will you communicate the plant to generate support?

Now put all this information in an Action Plan Form. Most of the information you need should come from your answers to the questionnaire. The specific task, or step, to be accomplished is written in the first column under “Action.” In the following column list the person who is responsible for completing this

task. A performance standard should then be provided. This standard is a way of establishing how well a task needs to be performed. Under "monitoring technique" enter a measurable goal or target used to track the plan's implementation. A firm deadline should then be set, and finally, indicate the resources that are needed to perform each task. This form will help you organize your thoughts, keep track of all the actions that need to be completed, and ensure that the proper quality is being maintained.

Use the form provided to track implementation of the project and to measure its success. A sample action planning form is included at the end of this section.

Overall Target: Employee Incentive Program					
Action	Responsible person	Performance standard	Monitoring technique	Completion deadline	Resources needed
1.Develop Program incentives	Carol	List of incentives	Discuss ideas with Marge the owner	Jan 15	Team of Carol and Mark
2.Design a program for review and giving incentives	Marcy	Approved program by Marge	Marge approves, allocates funding.	Feb 1	Action #1 complete
3. Meet with employees	Carol, Mark and Marge	Highly interactive meeting	Question employees before and after	Feb 15	Firm date for meeting; meeting room
4. Set up improvement/suggestion box, system	Carol	System in place, all employees are aware, easy to use	Number of ideas submitted	March 1	Box, access to company computer, review team
5. Review Team	Carol and Mark	Review team reviews suggestions monthly	Marge evaluates work	March 7	Ideas accepted/implemented
6. Incentives awarded	Marge	Ideas implemented, paying off in $$, improvements	Check on progress, success	June1	Cash bonuses, days off, etc

Congratulations!!! You have completed the Pollution Prevention Training. Now it is time to put these tools to work and remember pollution prevention is an ongoing process. If you continue to implement pollution prevention in your business, you will increase the efficiency of your process while helping the environment. Simply revisiting your process maps and Pareto Chart once a year and using the tools to continue to make improvements will make a big difference in your operation. Ongoing use of these tools will help you to participate in the Green Zia Environmental Excellence Program.

Here are a few suggestions to make pollution prevention continue to work for you:

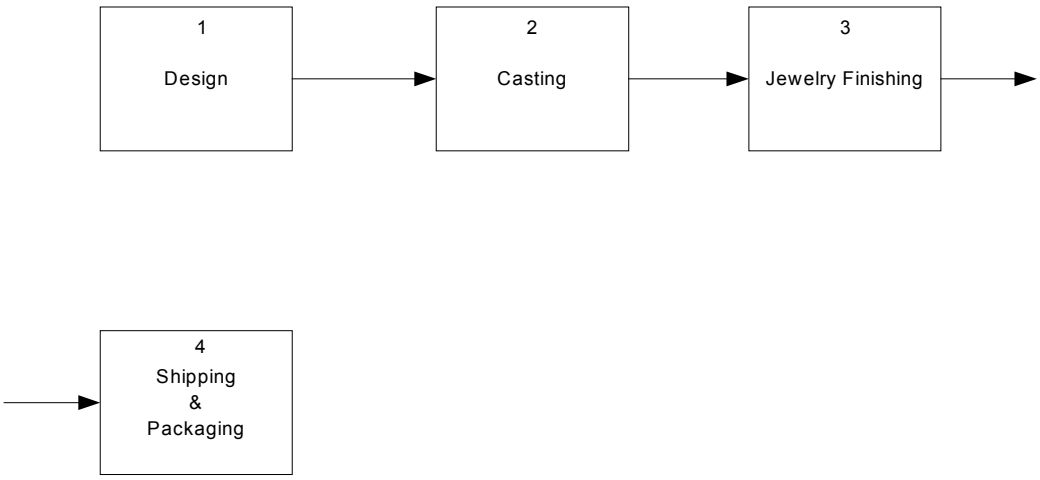
- Return to the Nothing to Waste activities and concepts as you make environmental improvement decisions.
- Schedule regular pollution prevention reviews of your business.

Remember: Pollution Prevention saves resources, saves money, and prevents accidents!

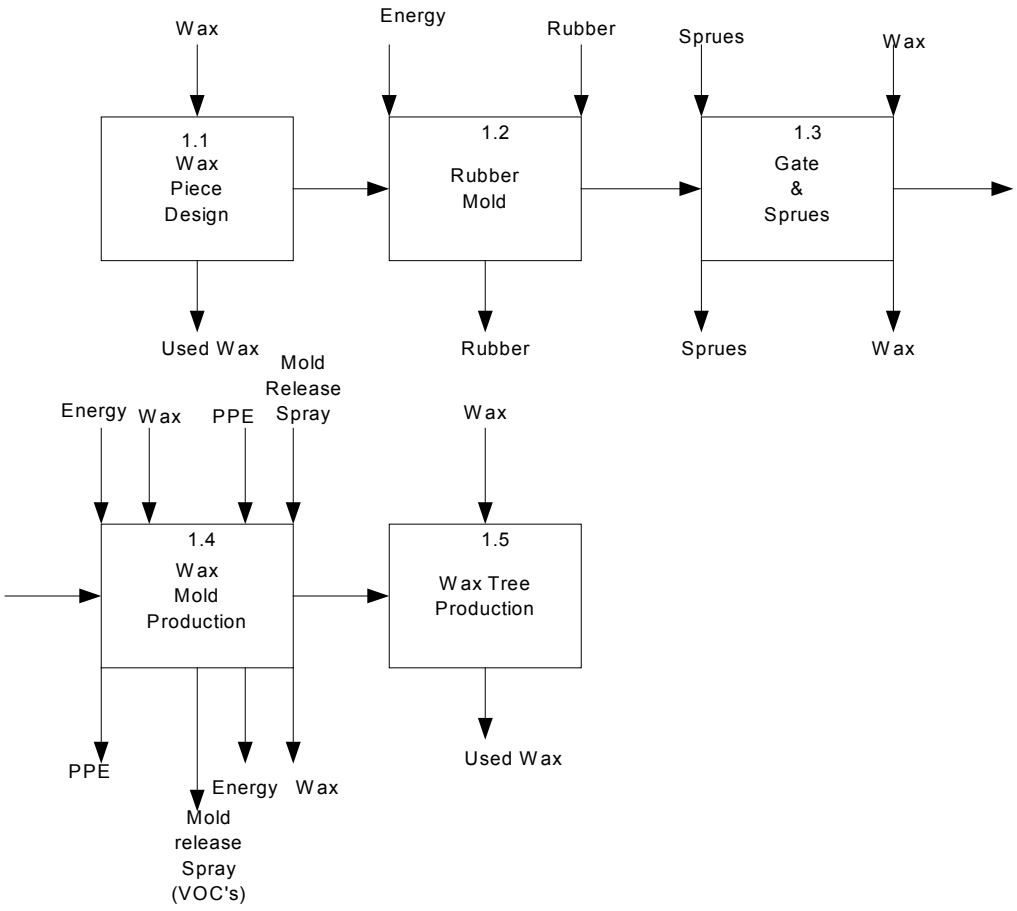
Overall Target					
Action	Responsible person	Performance Standard	Monitoring Technique	Completion Deadline	Resources Needed
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

Process Maps for Jewelry Manufacturing

General Overview Map of Jewelry Manufacturing



Process Map 1.0 Design



Process map 1.0: Jewelry Design

1.1 Wax Piece Design

During this process, employees design the wax pieces that will be used for molds later. This process generates used wax waste.

1.2 Gates and Sprues

Employees design gates and sprues for future casting. During this process, proper design allows casting metals to move smoothly into casting forms. This process requires the usage of sprues and wax. The wastes generated are used sprues and wax.

1.3 Wax Mold Production

During this process, employees mold the wax to establish the shape for the future jewelry pieces. This process requires the use of energy, PPE and mold release spray. The waste generated during this process is used PPE, mold release spray (may contain VOCs), energy and wax.

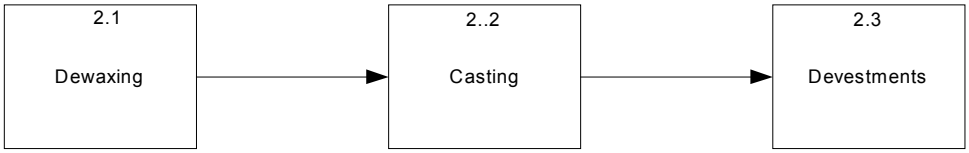
1.4 Create Rubber Mold

Employees prepare rubber molds from the wax pieces that have been prepared. There are many types of molding compounds. These compounds range from standard natural latex to vulcanizable rubbers to the room temperature vulcanizing silicones. This process uses energy and rubber. Waste rubber molds are generated in this process.

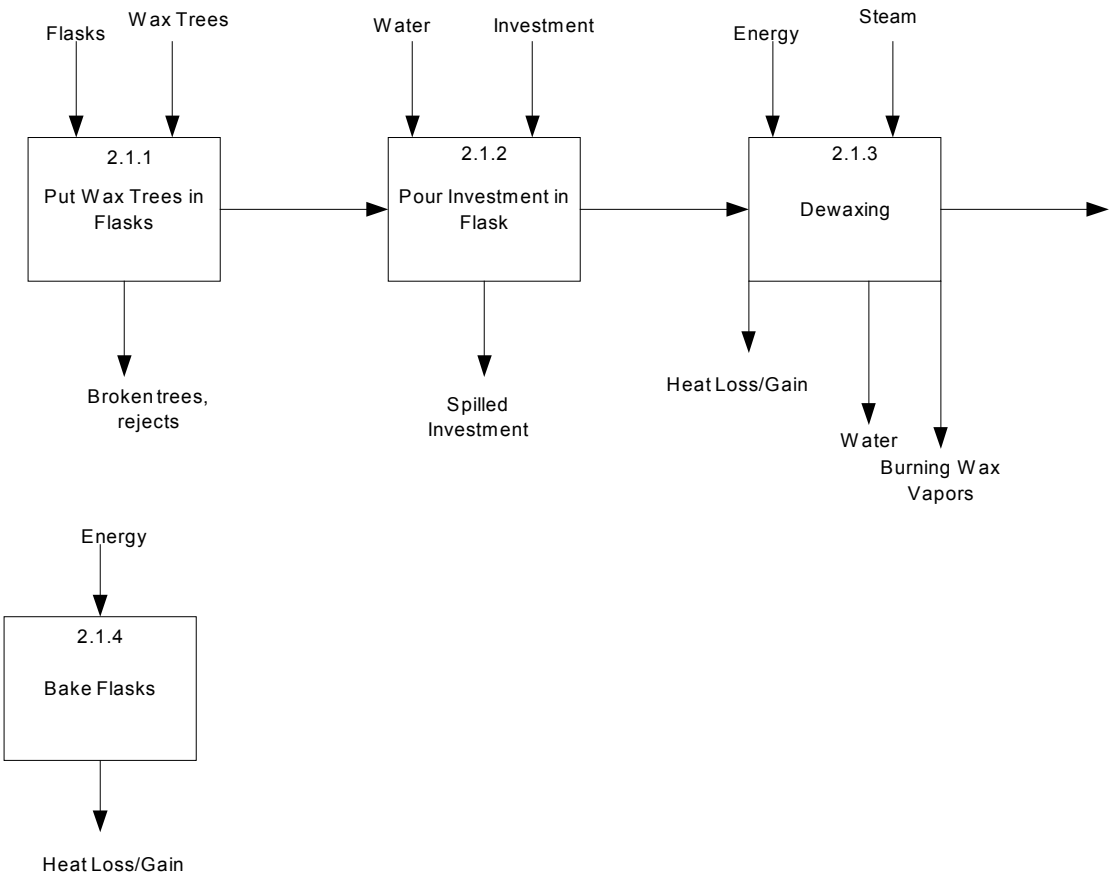
1.5 Wax Tree Production

The wax trees are produced to mount future jewelry pieces onto the tree for further processing.

Process Map 2.0: Casting



Process Map 2.1: Cast Preparation



Process Map 2.1: Cast Preparation

2.1.1 Place Wax Trees in Flasks

Employees prepare the casting. The wax trees are put into flasks. Wastes generated include broken trees and rejects.

2.1.2 Pour Investment

Investment is poured in the flasks to create cast. Investment is mixed with water to the proper consistency and is poured into flasks over wax trees. This process requires investment and flasks/casts. Waste materials may include spilled investment or damaged molds.

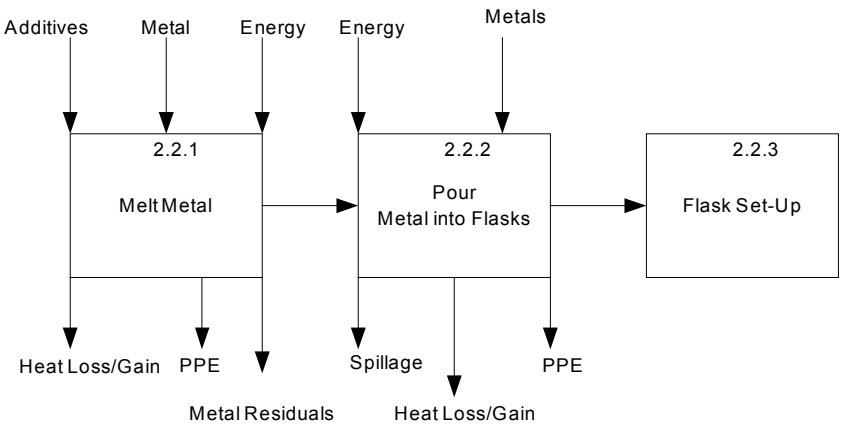
2.1.3 Dewaxing

During this process, wax is removed from the flasks by heat or steam. Typically steam is used. The waste generated during this process is energy, water, and wax vapors.

2.1.4 Bake Flasks

Flasks are baked overnight at high temperatures. This uses a significant amount of energy.

Process Map 2.2: Casting



Process Map 2.2: Casting

2.2.1 Melt Metal

Metal is melted to pour into flasks. Crucibles are used to heat the metal. The crucibles are heated gradually. This process requires energy, crucibles, tongs, shanks, metals, and flasks. The wastes generated are spillage, energy and used PPE. Worker health and safety issues are important in handling heated materials. Wastes generated are energy, air emissions, spilled metals, and PPE.

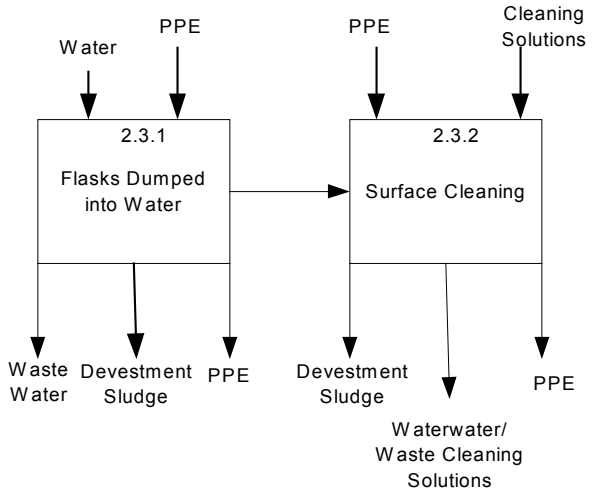
2.2.2 Pour Metal into Flasks

During this process, employees pour molten metal into flasks or casts using a ladle or a crane if it is a large operation. This process requires energy, metal, flasks, shanks, and a ladle or crane. Again safety issues are very important in handling heated materials. The wastes generated are spillage, energy and used PPE.

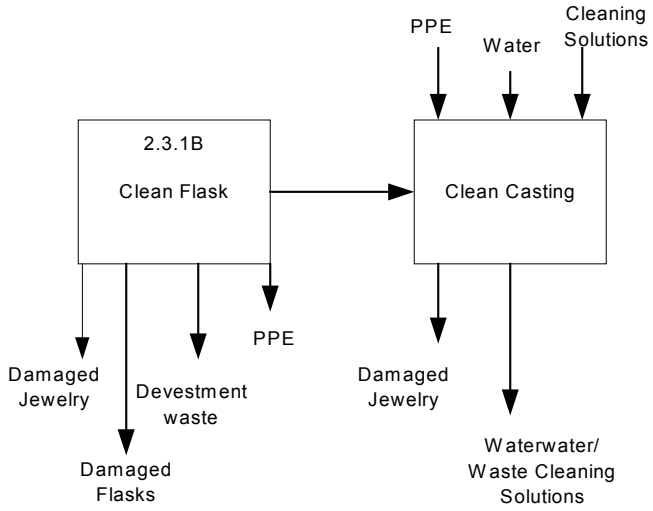
2.2.3 Flask Set-Up

Flasks are set-up to allow metal to solidify.

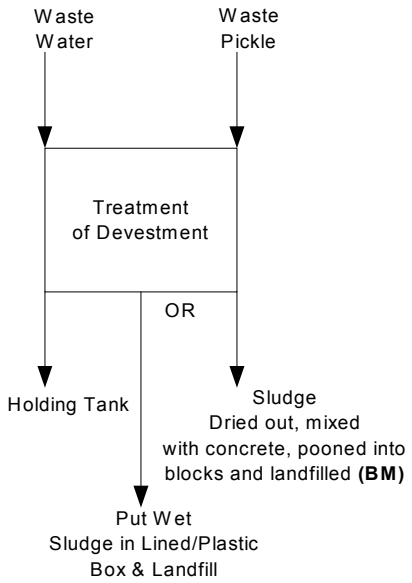
Process Map 2.3 (W): Wet Devestment



Process Map 2.3 (D): Dry Devestment



Management of Devestment Waste 2.3 A



Process Map 2.3: Devestment

2.3 Devestment is the process of removing the casting investment from the casting flask and tree. Two methods are generally used 1) Wet devestment; and 2) dry devestment. Wet processes use water to break apart the investment while dry processes use a flask-stripping device to push and shake the investment out of the flask and off the tree.

2.3.1 (W) Wet Devestment

Employees place the flasks into a sink full of water so they can soften the casts and break off the investment. Employees use a high-pressure hose to clean off residual investment. This process generates used PPE, water, energy, and investment sludge waste.

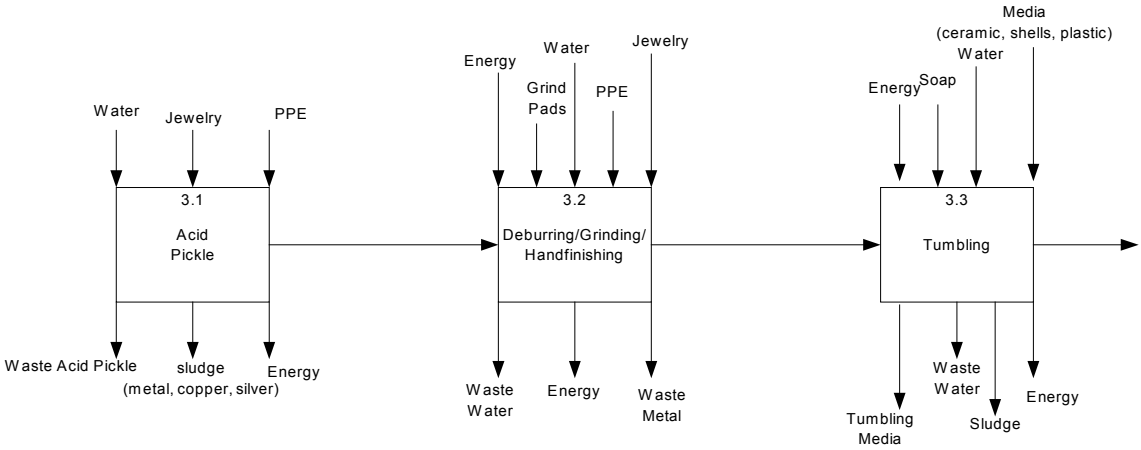
2.3.1 (D) Dry Devestment

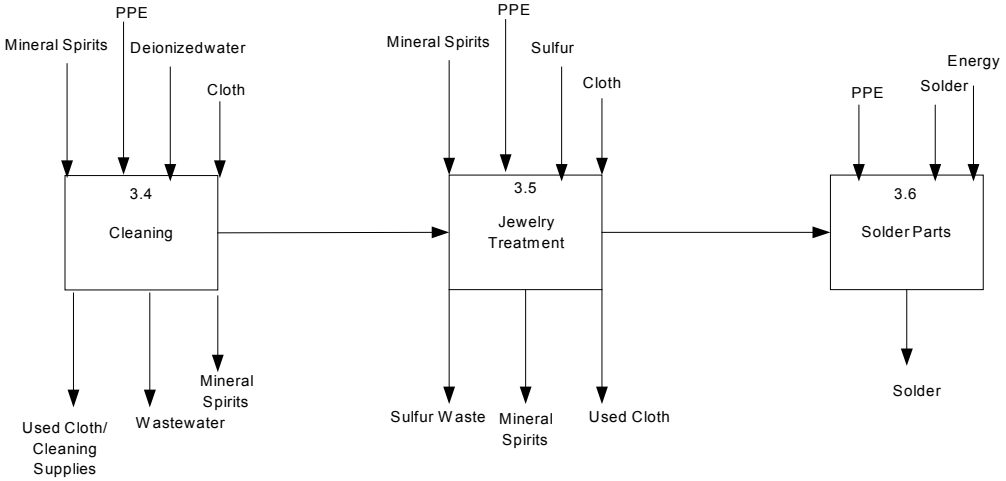
The casting tree and investment from the flask are pushed and shaken out of the flask and off the tree without the need for water. The castings are not as clean and may require additional cleaning using water, mineral spirits, or acid pickle. The wastes generated are dry investment, potential for damaged jewelry, energy and used PPE.

2.3 A Management of Devestment Waste

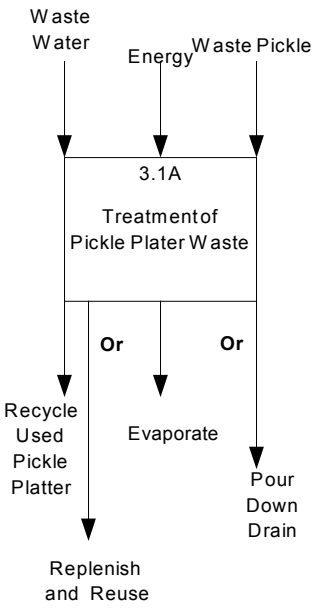
Devestment wastes are settled out of the used water by using holding tanks with baffles. The devestment sludge is taken out of the settling tanks, dried, put into lined cardboard boxes, then put into a dumpster. Another option is to dry the sludge, mix with Quickcrete, put into lined cardboard boxes and dispose at the local landfill. Alternatives for disposal have been investigated through New Mexico State University. One potential reuse is finger dust for rock climbing.

Process Map 3.0: Jewelry Finishing

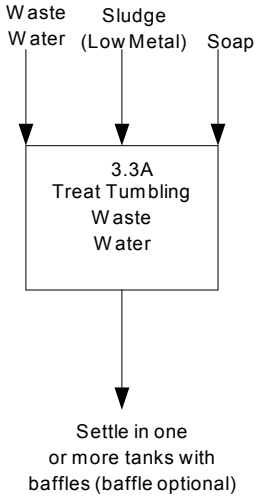




Process Map 3.1A: Management of Acid Pickle Waste



Process Map 3.3 A: Management of Tumbling Waste Water



Process Map 3.0 Jewelry Finishing

3.1 Acid Pickle

The jewelry is placed into a heated acid pickle solution to remove oxides of copper and zinc. This process generates used acid pickle and energy and produces an acid pickle waste.

3.2 Deburring/Hand Finishing/Grinding

During this stage, employees remove casting tree spurs or additional casting metals from the castings. Employees grind off residual metals from the castings using a grinding wheel and an abrasive pad. While some deburring can be achieved in a mass finishing operation, hand deburring is common. Most of the metal from a deburring operation is recoverable either through settling tanks, filtration, or a combination in the recovery process. The waste generated during this process is PPE, energy, and grinding pads.

3.3 Tumbling

Jewelry pieces are put into a tumbler along with water, soap and media, (media is either ceramic, steel shot, or natural; ground corncobs, walnut shells, etc.) The jewelry pieces are tumbled with the media and soap in order to shine and clean the pieces. This process generates wastewater, sludge, and energy.

3.4 Cleaning

Mineral spirits and other alcohol-based cleaners are sued as a final product rinse. They can be replaced by deionized water. The wastes from this process include q-tips, cloth, mineral spirits or other cleaning solutions.

3.5. Antiquing

In some cases, an antiquing process is used to give some jewelry pieces an antique finish. The waste material from this process is used mineral spirits, hand cloths, used PPE.

3.6 Soldering

Soldering can be divided into hand solder (silver or gold solder) or brazing with a filler metal. Silver solder is used for solder joints. This process uses a solder gun, PPE, energy, solder, tips and flux. The waste generated from this stage is a small amount of flux and fumes.

3.1 (A) Management of Acid Pickle Waste

3.1.1 Option 1: Treatment of Acid Pickle with Pickle Plater

The acid pickle can be reclaimed using the pickle plater. The plater is used to remove the metals from the acidic solution. Once the copper is plated out from the waste acid pickle the acid pickle can be reused again. The copper may be resold.

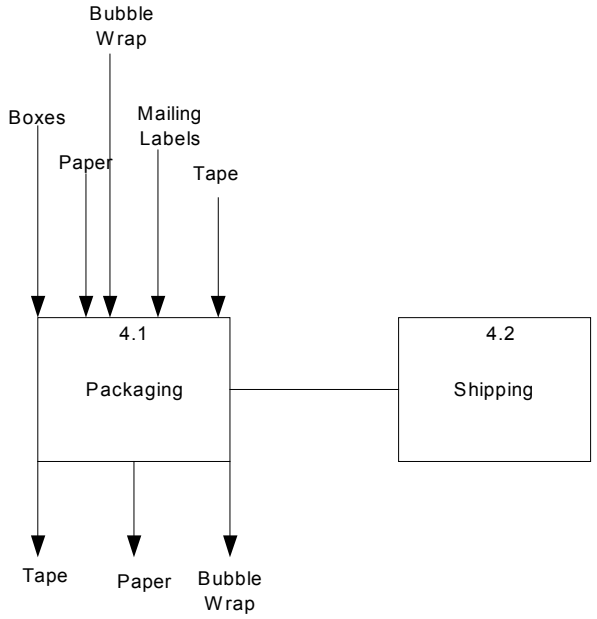
3.1.1 Option 2: Treatment of Acid Pickle by Evaporation

This is an option for small businesses. Acid pickle is evaporated. The dried sludge must be tested using the TCLP method. If testing determines that it is not hazardous, it may be landfilled. If the testing determines that the waste is hazardous, it must be disposed of as hazardous waste.

3.1.1 Option 3: Acid Pickle is continually replenished.

As the acid pickle evaporates, more solution is added to the heated pot and it is used continually. This may reduce the effectiveness of the pickle solution over time.

Process Map 4.0: Packaging and Shipping



Process Map 4.0: Packaging and Shipping

4.1 Packaging

Jewelry is packaged for shipping. Materials include boxes, invoices, paper, special packing materials, labels and tape.

4.2 Shipping

Packages are shipped using appropriate service.

Regulatory Guidance Materials and Pollution Prevention Tips

City of Albuquerque P2 Program:

Jewelry Tip Sheet For Reducing Liability & Protecting The Wastewater Treatment Plant

Areas of opportunity for reducing toxic discharges to the sanitary sewer system include:

1. *Before discharging any type of wastewater to the sanitary sewer system call your local treatment plant, or the Industrial Pretreatment Program to find out if there are any restrictions.*
2. *Wastes that affect the treatment system include heavy metal wastes, chemicals that are listed as toxic or hazardous.*
3. *All facilities that have materials that are or could be considered hazardous should have a written spill prevention plan.*
4. *Training programs regarding proper handling of wastes and chemicals for operators and maintenance personnel are essential.*
5. *Records of how wastes are handled is another factor in making sure that you are meeting wastewater ordinance requirements.*
6. *Inspection and spill control plans are also required.*
7. *Proper maintenance and operation of your wastewater treatment system(s) are fundamental in insuring that your facility is meeting the local wastewater ordinance.*
8. *Ensuring that chemicals and wastes are not stored next to a floor drain, and are elevated and contained properly will guarantee that you are not in violation with your local wastewater ordinance.*

Cyanide Bombings Hidden Costs

Cyanide bombing is an outdated process used to remove oxide materials from casting. The chemicals used in the bombing process makes this a dangerous operation with potentially **dangerous consequences**. Cyanide is a regulated hazardous material. Cyanide is highly toxic. If you are using cyanide to finish jewelry:

1. *You will need to analyze the waste using the Toxicity Characteristic Leaching Process in order to determine if there are hazardous metals present.*
2. *You will need to perform full cyanide oxidation or destruction*
3. *Most likely the waste will be hazardous and will have to be treated and shipped as hazardous waste.*
4. *Because cyanide is highly toxic it will need to be stored properly and employees must use full Personal Protective Equipment.*

Reusing Acid Pickle

Acid Pickle, when used to clean sterling silver and copper alloys, will contain a large amount of copper. Copper is not hazardous, but could cause major problems for sewer treatment facilities. Also, due to their corrosiveness acid pickles are hazardous wastes. The primary reason not to discharge acid pickles is that they can be continuously reused and the copper can be removed for recycling. The primary method for reuse and recycling is to use an Acid Pickle Plater. The plater, plates out the metals from the acidic solution. Once the copper is removed the acid pickle can be reused. Please call the **City of Albuquerque's p2 Program at (505)873-7058** for specifications for building and using the pickle plater.

Why Do I Need A Spill Prevention Plan?

It is required that any business handling materials that are or may be considered hazardous to have a ***Hazardous Material Emergency Response Plan*** **(HMERP)** in case of spills. The HMERP should be filed with your local fire department. By preparing and filing your Spill Prevention Plan with your local Fire Department you will be fulfilling part of the requirements under RCRA, as well as the requirements of your local treatment plant.

Some General Spill Control Procedures Include:

1. *Isolating the spill area and limit entry.*
2. *Tending to any injured or contaminated personnel*
3. *Notifying the proper authorities*
4. *If the spill is treated on site, dispose of the spill in accordance with federal state, and local regulations.*

Pollution Prevention Factsheet for the Jewelry Industry

Overview of Industry Waste Streams:

Most of the pollution generated by both small and large jewelry manufacturers can be categorized as either heavy metal (silver, zinc, nickel, copper, cadmium, etc.) wastes or spent solvent wastes, some of which contain cyanide from stripping processes. Much of the heavy metal wastes and spent cyanide which is not recovered through filtration and distillation methods, is discharged to wastewater treatment facilities where high concentrations of these pollutants can cause malfunctions in the water treatment equipment, leading to poor treated water quality and poor sludge quality (sludge is often reused agricultural or incineration processes). Furthermore, many of these wastes pose serious health hazards to workers and the general public if allowed to contaminate ground water sources. Improper disposal, leaks and spills, inadequate employee training, and process inefficiencies can all increase the risk of adverse human and environmental exposure to these toxic substances. Reducing this risk by solvent reuse and increased metal recovery, is a cost effective means of increasing employee safety, while establishing a good public relations base. Though initial process alterations or equipment retrofitting may require a limited capital investment, case studies have demonstrated great returns in the reduction of regulatory disposal costs, water usage, and regular operational costs, especially raw material procurement.

The purpose of this factsheet is to provide information on the hazards associated with particular pollutants commonly employed or produced by jewelry manufacturing processes, while offering some guidelines and resources which can aid in the reduction or elimination of these materials. Finally, several case studies will be outlined in order to demonstrate the potential economic gains of pollution prevention efforts as well as the ingenuity employed toward this goal. As much of jewelry industry is focused on the artistic expressions of the individual jeweler, the manufacturing processes utilized throughout the industry are very diverse. For this reason, the creativity of the individual jeweler is often the key to effective pollution prevention.

Specific Hazards Associated with Major Wastes:

For a more comprehensive list of hazard descriptions, refer to the U.S. Environmental Protection Agency web page, http://www.epa.gov . By searching this page for jewelry related articles, information on wastes, regulatory codes, and businesses currently being investigated or cited by the EPA can be accessed.

Silver: Most commonly found as a ground water contaminant, silver causes a condition known as Agyria, a permanent blue-gray skin color, as well as causing irritation in the eyes and mucous membranes which line the human digestive tract. Effective water treatments to remove silver are ion exchange systems, in which electrically charged plates are used to attract the electrically charged silver, reverse osmosis, where a semi-permeable membrane is used to filter the silver out of the water stream and distillation, where the water is evaporated leaving the silver behind.

Cadmium: Cadmium, which occurs naturally as an impurity in various ores and was historically used as a solder base, can cause nausea, vomiting, muscle cramps,

convulsions, and shock. Chronic, or long term, exposure can cause kidney, liver, bone, and blood damage. According to 1986 figures (these being the most current available), 35% of the cadmium waste is a product of metal plating processes, while 5% is due to alloy wastes.

1,1,1- Trichloroethane: Known as both 111-TCE and 111-TCA, 1,1,1- trichloroethane is a toxic halogenated hydrocarbon solvent, most commonly used as a general purpose cleaner. The EPA has recently cited a number of jewelry manufacturing businesses for failure to report the disposal of this RCRA hazardous waste. Many effective alternative solvents are available, for suggestions as well as specific toxicity information on 111-TCE refer to the "General Solvent Factsheet".

Cyanide: Cyanide compounds that contain a complexed carbon-nitrogen functional group (C≡N) are highly toxic and regulated as hazardous wastes. When cyanides come in contact with acids, such as many cleaning solvents, hydrogen cyanide gas is emitted. This hardly detectable gas will very quickly kill anyone in the vacinity. Cyanide compounds, such as sodium cyanide, metal stripping agents, and electroplating chemicals, can be fairly easily replaced by less harmful chemicals, which though not as convenient are much more cost effective and safe.

Pollution Prevention Opportunities:

For a step-by-step pollution prevention process review guideline and pertinent case studies, refer to the "Jewelry Manufacturing Code of Practice Checklists" distributed by the City of Albuquerque Pollution Prevention Program. For a copy, call the Pollution Prevention Program Office at (505) 873-7004, or write to Pollution Prevention Program, 4201 Second St. SW, Albuquerque, NM 87105.

Operational Assessment and Improvement:

Many common pollution prevention techniques are simply the development and identification of good operational procedures. These often include the education and training of employees who work around or with waste generating procedures, standardizing all procedures, carefully labeling and separating waste streams to eliminate cross-contamination, and the evaluation of solvent usage. Are cleaning processes completed unnecessarily or too frequently? Can the amount of solvent used be reduced? Can the solvent or wastewater be reused, and if so how many times? The answers to all of these questions are dependent on the individual processes employed by the manufacturer.

The next level of pollution prevention involves an analysis of the manufacturing processes themselves. Which steps create the most costly waste streams? Are there suitable alternatives that lower or eliminate the level or toxicity of waste discharge? For instance, several jewelry manufacturers have found that they can reduce waste water disposal costs by reusing the solvents used in the acid pickling process or eliminating the process altogether. Other facilities have increased dissolved metal reclamation by experimenting with finer filtering apparatus or integrating electrolytic recovery systems which separate the metal from a solvent by creating an electric potential which attracts the conductive metal ions. These processes often have two fold economic returns, an increase in reusable metal and a decrease in costs of wastewater disposal.

SPECIFIC REGULATORY GUIDANCE FOR JEWELRY MAKERS

This briefing paper is intended to be attached to the "General Regulatory Guidance for New Mexico Small Businesses" to provide additional regulatory information specifically to "Jewelry Makers". It is not intended to be a substitute for actual regulations. If you have questions concerning your regulatory responsibilities, you are encouraged to contact the appropriate bureau.

AIR EMISSION REGULATIONS:

Jewelry manufacturers usually don't have air emission problems. The exceptions may be those facilities that also include a foundry or use materials that contain VOCs in large quantities. If in doubt about the air regulations, you can contact the NMED Air Quality Small Business Assistance Program at 505-827-1294 or the City of Albuquerque Air Quality Assistance Program at 505-768-1964 if your business is located in Bernalillo County.

HAZARDOUS WASTE REGULATIONS:

Attached to this briefing paper is a document entitled "Fact Sheet for Jewelry Manufacturing Facilities" that can assist you in being compliant with Hazardous Waste Regulations.

WASTEWATER REGULATIONS:

The most potential problem for jewelry manufacturers is dealing with the rinse water. Since this wastewater can contain recoverable materials, it can easily be recycled. Be careful about putting your wastewater into the sewer system. Metals can play havoc with Publicly Owned Treatment Works (POTWs).

OSHA REGULATIONS:

Attached to this document is a checklist entitled "Jewelry Shops (A Hazard Identification Checklist)" that can assist you in being compliant with OSHA.

UNDERGROUND STORAGE TANK REGULATIONS:

There is nothing unique about jewelry making that isn't already covered in the General Regulatory Guidelines.

SOLID WASTE REGULATIONS:

There is nothing unique about jewelry making that isn't already covered in the General Regulatory Guidelines.

GENERAL REGULATORY GUIDANCE FOR NEW MEXICO SMALL BUSINESSES

The purpose of this briefing paper is to assist small businesses in New Mexico in trying to understand the environmental regulatory requirements associated with doing business by giving a general overview. It is not intended to be a substitute for actual regulations. Businesses are responsible for operating their business in full compliance of the law (regulations). Each bureau in the New Mexico Environment Department (NMED) have staff available that can help you directly in understanding what is expected of your business from a regulatory point of view. It is in your best interest to contact the appropriate bureau if you have questions.

Periodically the Pollution Prevention (P2) Program in NMED will issue specific guidance briefing papers as an attachment to this document for certain businesses. These will be designed to provide additional information to a specific business. For information call the NMED Pollution Prevention Program staff at 505-827-0677 or the Technical Resource Center in Albuquerque at 505-843-4251.

AIR EMISSION REGULATIONS:

The EPA, in an attempt to control air pollution through regulations, has created a set of rules with many acronyms. Since businesses can come across these acronyms in many publications, they are listed below:

NESHAP: National Emission Standards for Hazardous Air Pollutants
NAAQS: National Ambient Air Quality Standards
HAP: Hazardous Air Pollutants
TAP: Toxic Air Pollutants
OEL: Occupational Exposure Limits
VOC: Volatile Organic Compounds
MSDS: Material Safety Data Sheet
CTG: Control Techniques Guidelines
MACT: Maximum Achievable Control Technology
BACT: Best Available Control Technology
GACT: Generally Available Control Technology
RACT: Reasonably Available Control Technology

Much of the national strategy for controlling air pollution centers around the NAAQS. These standards set limits for the concentration in the ambient (outdoor) air of the six most common air pollutants: Ozone, Carbon Monoxide, Particulate Matter, Sulfur Dioxide, Nitrogen Dioxide, and Lead.

The EPA has established industry based regulatory requirements for the most serious air pollutants, such as HAPs. In many cases the EPA has also established Control Techniques Guidelines that require industries to use certain technologies, such as MACTs.

Any business that has the potential of releasing pollutants to the ambient (outdoor) air, such as VOCs, HAPs, or Criteria Pollutants may be subject

to the Air Quality Regulations depending on the amount of pollutants being released. These pollutants are used to determine if a facility is a major or minor source of air pollution and whether or not a business will need an Air Quality Permit. A major source is determined as a function of the amount of HAPs or Criteria Pollutants a business has the potential to emit. For HAPs it is 10 tons per year of any single HAP or 25 tons per year of the total HAPs. For the Criteria Pollutant it is 100 tons per year of any criteria pollutant. In addition the State of New Mexico has added TAPs as a category to be regulated.

Some businesses that would normally be considered a major source can be classified as a minor source by changing the way they conduct their business. Businesses classified as a major source have significant regulatory requirements such as annual fees, maintaining progress reports, records, and a compliance schedule, monitoring emission limits, as well as the possible requirement to have specific control technology installed (MACT, GACT, or RACT). All major sources are required to obtain a Title V Permit. It is generally desirable for a business not to be classified as a major source. An EPA document “Potential to Emit, A Guide for Small Businesses” (EPA-456/B-98-003) is available from the EPA and it may help you to understand Air Quality Regulations.

The State of New Mexico, in addition to HAPs and Criteria Pollutants, has also generated regulations on Toxic Air Pollutants (TAPs) with OELs. These basically limit businesses from allowing TAPs to be emitted to the outside air around their building. OSHA regulates the same kinds of exposure limits inside of a building.

Due to the complexities of Air Quality Regulations, the harm air emissions cause to the environment, and in many cases the high costs associated with “end of the pipe” control technology, it is in the best interest of any business to evaluate their operations with the ultimate goal of eliminating all air pollutants as much as possible.

What all this means is, with few exceptions, the Air Quality Regulations that apply to your business will mostly be determined by what your business does. The best way to find out what air quality regulations apply to your business is to contact the New Mexico Environment Department (NMED) Air Quality Small Business Assistance Program (SBAP) at 505-827-1294. Businesses that are located in Bernalillo County are locally regulated with respect to air emissions. For assistance you need to call the City of Albuquerque/Bernalillo Air Quality Assistance Program (AQAP) at 505-768-1964.

HAZARDOUS WASTE REGULATIONS:

Any business that generates waste that is classified as “listed” or “characteristic” in RCRA must deal with this waste as outlined in the New Mexico Hazardous Waste Regulations. The EPA has generated a list of chemicals that are considered hazardous. They have also stated that certain materials that exhibit a hazardous characteristic (ignitibility, corrosivity, reactivity, or toxicity) should be considered hazardous. To determine which products used in your business contain hazardous material, contact either the EPA or the New Mexico Hazardous Waste Bureau. In some cases this information will be contained on the Material Safety Data Sheet (MSDS) that came with the product.

It is important to understand that any product that contains “listed” or “characteristic” material is only regulated by the hazardous waste regulations when it becomes a waste. Examples are when the product is no longer to be used for its intended purpose and is to be gotten rid of, the shelf life of the product has expired, the product leaks from a piece of equipment, or the product is accidentally spilled. It is also important to note that any product to be discarded that contains one or more hazardous materials is also hazardous waste. Examples are hazardous waste mixed with solid waste, rags to clean up spilled hazardous materials, or wastewater from a process that used a hazardous material.

All businesses that generate hazardous waste are classified based on the quantities of hazardous waste they generate monthly. The three classifications are:

1. Conditionally Exempt Small Quantity Generator (CESQG): generates less than 220 pounds or 100 kilograms of hazardous waste per month. A CESQG cannot accumulate more than 2,200 pounds or 1,000 kilograms of their combined hazardous waste at any one time. Usually this amounts to about one-half of a 55-gallon drum. CESQG’s may dispose of their hazardous waste by mixing it with a solid waste, assuming there are no free liquids in the waste, and taking it to a permitted municipal solid waste (MSW) landfill. You need to verify that the MSW landfill will accept the mixed waste.

2. Small Quantity Generator (SQG): generates between 220 pounds and 2,200 pounds or 100 kilograms and 1,000 kilograms of hazardous waste per month. No more than 13,200 pounds or 6,000 kilograms may be stored on site any longer than 180 days and must be disposed of at a facility permitted to recycle, treat, store, or dispose of hazardous waste.

3. Large Quantity Generator (LQG): generates more than 2,200 pounds or 1,000 kilograms of hazardous waste per month. Hazardous waste with no weight limit may be accumulated for no more than 90 days unless permitted by the State.

Each classification has different record keeping, manifesting, and reporting requirements. Since a businesses’ classification is based on a monthly generation, it is possible to move from one classification to another on a regular basis. All generators of hazardous waste are required to register with the Hazardous Waste Bureau and pay a generator fee based on their classification.

The Hazardous Waste Bureau has an established outreach program that can assist any business in determining their classification and the regulatory requirements that go with it. You may contact the Bureau at 505-428-2528.

It is important for any business generating hazardous waste to understand that RCRA has established a “cradle to grave” responsibility for the generator of said waste. In effect this means that if the hazardous waste the business generates contaminates soil, surface water, or ground water in any manner until it is properly disposed of, the business will be held responsible for the clean up of the contamination. The cost of clean up could be substantial. It is therefore imperative for any business to

make sure trained employees handle their hazardous material properly to avoid accidental spills, to only use permitted haulers, to make sure their waste goes to a RCRA permitted facility, to properly store their hazardous waste, and never dispose of their hazardous waste at their facility. It is also advisable to seal the floor of the facility if you use a hazardous material in a liquid form in your operation.

The best way for any business to avoid the costs of contamination clean up is to eliminate the use of hazardous materials in their operation. A complete understanding of how a business conducts its processes is required to determine the best way to eliminate or at least reduce the amount of hazardous waste being generated. A Pollution Prevention Program has been established at the New Mexico Environment Department to assist businesses in evaluating their processes. The number to call at NMED is 505-827-0677 or you can call the Technical Resource Center in Albuquerque at 505-843-4251.

The New Mexico Environment Department has a 24-hour emergency reporting number that can be called in case of an incident dealing with hazardous material. The number is 505-827-9329.

WASTEWATER REGULATIONS:

Any business that generates wastewater that contaminates surface water or ground water can be held responsible for the cost of cleanup. If the contaminant is a RCRA “listed” or “characteristic” waste above the concentration value allowed, then the wastewater is by definition a hazardous waste and must be dealt with under New Mexico Hazardous Waste Regulations. Placing hazardous wastewater directly onto or into the ground is strictly prohibited. Since the cost of cleaning up either surface water or ground water can be substantial, it is in the best interest of any business to eliminate, minimize, and/or control its wastewater.

If non-hazardous wastewater is being discharged so that it can move directly or indirectly into ground water (e.g. septic system, dry sump, etc.) a business is required to file a “Notice of Intent to Discharge” with the New Mexico Ground Water Bureau in accordance with the NM Water Quality Act. The Bureau will then determine if the business requires a Discharge Permit. In some cases the business may be required to request a NPDES Permit from the EPA if the discharge is to surface water.

If non-hazardous wastewater is being place into a sewerage system a business is required to notify the local Publicly Owned Treatment Works (POTW) the nature and concentrations of the contaminants in the wastewater. Attached is a listing of the New Mexico Publicly Owned Treatment Works. Wastewater that has been determined to be hazardous is prohibited from being placed in any sewerage system.

Business need to be aware that even though their wastewater going into the sewerage systems is allowed by the POTW, this does not necessarily relieve them of potential contamination liability. A good example is the case in which a sewer pipe leaks and the wastewater contains hazardous constituents, below RCRA levels, that were generated by your business. Over time the wastewater seeps into the ground water and the concentrations exceed State or Federal water quality standards. If the

contamination source can be traced back to your business, you could be liable for the cost of cleanup. Most businesses will find that the costs associated with proper handling of their wastewater are far cheaper than the cost of cleaning up ground water. Prevention is an inexpensive insurance policy.

Another potential source of contamination is through the foundation of your building. An example would be where a business handles hazardous material as a regular part of doing business and a spill occurs that seeps through cracks in the floor. Eventually it reaches ground water and is detected through monitoring of the ground water. Assuming it can be traced back to your business, you could then be held responsible for the cost of clean up.

Any business that generates wastewater from sources other than lavatories, cafeterias, etc., should evaluate ways in which the wastewater can be eliminated, reduced, recycled, reused or handled in such a fashion that the risk of liability for contaminating surface water or ground water is virtually zero. This should include dealing with hazardous waste and all wastewater in a proper fashion, sealing cracks in floors, training of employees, and possible treatment of their wastewater before it leaves their premises.

If you have any questions you can contact the Ground Water Bureau at 505-827-2919 and the Surface Water Bureau at 505-827-0187.

OSHA REGULATIONS:

Every business is required to provide a safe and healthy working environment for its employees. The Occupational Health and Safety Bureau (OHSB) is responsible for making sure businesses are in compliance with OSHA regulations. OSHA regulates permissible exposure limits (PEL's) for employees exposed to certain air contaminants in the workplace. The Bureau conducts regular inspections of facilities and evaluates the establishment for safety and health compliance. The OSHB has a consulting program to assist facilities to be in compliance with OSHA regulations. The service is free of charge to New Mexico small businesses. Attached is a copy of "Frequently Asked Questions" about the program, a copy of "General Health & Safety Issues", as well as a poster you are encouraged to display at your facility. They can be contacted at 505-827-4230.

UNDERGROUND STORAGE TANK REGULATIONS:

Any business that stores a regulated substance in an underground storage tank that is not directly connected to some sort of processing operation may or may not be regulated by the Underground Storage Tank Bureau (USTB). If the substance is a hazardous waste, it is regulated under RCRA and you would need to contact the Hazardous Waste Bureau. Since there are a variety of circumstances whereby UST regulations have jurisdiction, it is best to contact the USTB directly for guidance. They can be contacted at 505-827-0214.

SOLID WASTE REGULATIONS:

The Solid Waste Bureau (SWB) deals primarily with regulating solid waste facilities (non-hazardous waste landfills, transfer stations, and

recycling facilities) and illegal dumping. The only responsibility for a small business is to see that their non-hazardous waste is either sent to a recycler or to a permitted landfill by a registered solid waste hauler. For information the SWB can be contacted at 505-827-2775.

Pollution Prevention and Regulatory Compliance Contacts for New Mexico

STATE AGENCIES:

Green Zia Environmental Excellence Program

Dave Wunker
NM Environment Department
Office of the Secretary
PO Box 26110
Santa Fe, NM 87502
505-827-0677
FAX: 505-827-2836
E-mail:
dave_wunker@nmenv.state.nm.us

Air Quality Bureau

Steve Dubyk
NM Environment Departrnent
1190 St. Francis Drive
P.O. Box 26110
Santa Fe, NM 87502
505-827-2859
FAX: 505-827-0045
E-mail:
steve_dubyk@nmenv.state.nm.us

Hazardous Waste Bureau

Debby Brinkerhoff
NM Environment Department
2044 Galisteo
P.O. Box 26110
Santa Fe, NM 87502
505-428-2528
FAX: 505-827-1833
E-mail:
debby_brinkerhoff@nmenv.state.nm.us

Occupational Health & Safety Bureau

Kevin Koch
525 Camino de los Marquez, Suite 3
P.O. Box 26110
Santa Fe, NM 87502
505-827-4230
FAX: 505-827-4422
E-mail:
Kevin_koch@nmenv.state.nm.us

Ground Water Quality Bureau

Maura Hanning
NM Environment Department
1190 St. Francis Drive
P.O. Box 26110
Santa Fe, NM 87502
505-827-2945
FAX: 505-827-2965
E-mail:
maura_hanning@nmenv.state.nm.us

Solid Waste Bureau

E. Gifford Stack
NM Environment Department
1190 St. Francis Drive
P.O. Box 26110
Santa Fe, NM 87502
505-827-2853
FAX: 505-827-2902
E-mail:
gifford_stack@nmenv.state.nm.us

Underground Storage Tank Bureau

Joyce Shearer, Ph.D.
NM Environment Department
1190 St. Francis Drive
P.O. Box 26110
Santa Fe, NM 87502
505-476-3779
FAX: 505-827-0310
E-mail:
joyce_shearer@nmenv.state.nm.us

Please note that a list of all Public Owned Treatment Plants (sewage treatments plants) are listed for all of New Mexico on the following page. Waste Treatment Plant operators are important regulatory contacts for small businesses. Please refer to the list and contact your local plant operator for information specific to your community and business.

City of Albuquerque

Public Works Department

Bob Hogrefe
Southside Water Reclamation Plant
4210 Second Street, SW
Albuquerque, NM 87185
Ph: 873-7030
Fx: 873-7087
Rhogrefe@cabq.gov

Environmental Health Department

John Liberatore
EHD/APCD
P.O. Box 1293
Albuquerque, NM 87103
505-768-1964
FAX: 505-768-2617
E-mail: jliberatore@CABQ.gov

New Mexico State University

Chris Campbell
WERC P2 Center
1155 University Blvd., SE
Albuquerque, NM 87106
505-843-4251
E-mail: chrisc@werc.net

Online Resources:

City of Albuquerque P2 Program:www.cabq.gov

Additional Sources of Information:

The New Mexico Environment Department's Hazardous and Radioactive Materials Bureau offers free on-site technical assistance for small businesses to help address small business hazardous waste issues. Please contact the Bureau at 505-827-2528 and ask for the Hazardous Waste On-Site Assistance Program for a consultation.

The City of Albuquerque Public Works Department has a guidebook on pollution prevention for the jewelry manufacturing industry. Please contact Bob Hogrefe at 505- 873-7030 for a copy.

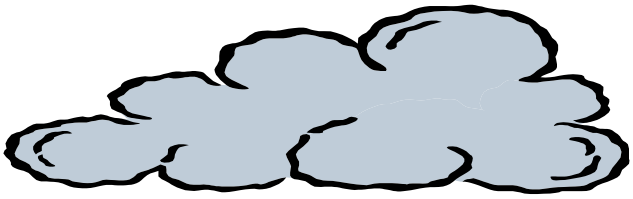
Understanding Solvents: Common Uses and Chemical Composition

Eliminate - Reduce - Reuse - Recycle - Exchange

Solvents are used to create a fluid environment in which reactions or processes can be run efficiently and effectively. Solvents influence pH and temperature factors that affect the binding mechanisms of soiling agents. The following paragraphs are intended to serve as an introduction to the **chemical composition**, **general activity mechanisms**, and **common uses** of various types of solvents.

Petroleum-Based Solvents

This group refers to a class of solvents that are used as **general-purpose cleaners**. Most petroleum-based solvents consist of a hydrocarbon "backbone" to which chemical functional groups and oxygen groups have been added. In these solvents, the inorganic functional groups are responsible for the activity of the solvent. The exception to this rule is a subclass of petroleum-based solvents called aromatic and aliphatic hydrocarbon solvents, which contain multiple bond arrangements and/or are bonded into ring confirmations. In these solvents, it is the carbon confirmation and arrangement of double and triple bonds between neighboring carbon atoms that give the solvent its activity.



Industry has chosen the petroleum-based solvents with low molecular weight, which have **high volatility**. The high volatility and reactivity of these solvents allows **maximum removal of soils** and contaminants, creating compatibility with varied work surfaces and subsequent process requirements while simplifying process and technique, thereby **minimizing costs**. Furthermore, because many soiling agents are organic compounds, ex.) grease, motor oil, waxes, and most lubricants, they are miscible in organic petroleum-based solvents, allowing for **quicker, more effective clean up**.

Due to their **high volatility**, total containment of petroleum-based solvents during application and waste storage is nearly impossible. The **atmospheric escape** of these solvents, many of which are classified as Volatile Organic Compounds (VOC's), has been shown to contribute to **stratospheric ozone depletion, air pollution through smog formation, and soil and groundwater contamination**.

Types of Petroleum-Based Solvents:

Halogenated petroleum-based solvents:

These solvents consist of the **highly reactive** functional groups chlorine, fluorine, or bromine. These halogens share the same number of electrons available to participate in chemical reactions. For this reason, the chemical reactivity of these solvents is less dependent on which halogen atom comprises a functional group than on how many functional groups are attached to the hydrocarbon "backbone," a number referred to as the **degree of halogenation**. A solvent with a high degree of halogenation has a **high volatility** and **strong cleaning properties**.

Higher energy levels in the bonds make the molecule more reactive, which can cause it to escape from the liquid phase into the gas phase and enter the atmosphere. The popularity of halogenated solvents arose from their **superior contaminant** and **soil expulsion properties**, **low flammability**, **compatibility with work surfaces** and process equipment, and **relatively low cost**.

Alternatives that Reduce Risk:

Though it is often advisable to seek non-halogenated alternative solvents because halogenated compounds are hazardous to human and environmental health, several new halogenated alternatives have been developed with short atmospheric lifetimes.

- n-Propyl Bromide:
  Many commercial "green" solvents have replaced their chlorinated solvents with n-butyl bromide because it is a nonflammable VOC with a 10-11 day atmospheric lifetime, giving it a **low Ozone Depletion Potential**. However, despite a low bio-accumulation potential, n-butyl bromide solvents are **non-biodegradable**, and in large volumes have the potential to penetrate soil and **contaminate groundwater**. Furthermore, they may **harm** some work surfaces, especially aluminum surfaces.

High-volatility oxygenated solvents:

In these solvents, the halogen functional group is replaced by an oxygen group such as a hydroxide group, such as alcohols; an ethyl group, such as ethers and esters; or a carbonyl group, such as ketones, aldehydes, and carboxylic acids. The hydroxide group has a similar chemistry to the halogen groups with one important exception: most of the oxygenated solvents are **highly flammable** and therefore **restricted** to applications such as ambient temperature immersion and manual wipe.

Oxygenated solvents are also prone to undergo reduction/oxidization (redox) reactions, which is the addition or elimination of double bonds or oxygen atoms. Although redox reactions in these solvents rarely result in more **toxic compounds**, the resulting solvent is **less effective** and **more flammable** under atmospheric conditions. For this reason, a warning not to mix with oxidizing agents often accompanies the oxygenated and aromatic and aliphatic hydrocarbon solvents.

Alternatives that Reduce Risk:

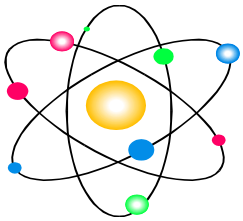
- Acetone:
  Excluded from the U.S. EPA's definition of VOC's due to its insignificant reactivity in the presence of sunlight, Acetone is a nonetheless a **highly volatile organic solvent**. Acetone is suitable as a drying agent and for ambient immersion or manual cleaning applications of soils such as greases, waxes, and inks. Due to its **high flammability**, safety cautions must be implemented during handling as well as during recycling. Although Acetone need not be reported under SARA 113, it is on the RCRA list of **hazardous wastes**, and must be **incinerated** for disposal.

- Alcohols (with perflourocarbons):
  Alcohols, mainly isopropanol, methanol, and ethanol, are excellent cleaning solvents for certain soils. The hydroxide functional group allows the alcohol to exhibit some of the same properties as water, while the hydrocarbon "backbone" allows the alcohol to dissolve low-molecular-weight oils. Alcohol solvents are often **biodegradable and water-soluble**. Alcohols are also **flammable VOC's and** as a result can only be used directly in manual and cold immersion applications, although their greatest efficacy occurs in heated or boiling liquid applications.

  This obstacle can be overcome by placing a perfluorocarbon vapor "blanket" above the heated cleaning system. This vapor "blanket" shields the solvent from atmospheric oxygen that causes combustion. Perfluorocarbons are **nonflammable** and have **low toxicity**, but are **costly** and have **high global warming potential**. Though they are immiscible in alcohol and easily separable and reusable, the capital and operational costs of perfluorocarbon systems are fairly high and prohibitive when other methods are available. Perfluorocarbons, which can be employed as solvents alone, have greatest potential in cleaning equipment that uses fluorinated lubricants or polymeric and elastomeric materials that are easily corroded by other solvents.

- Glycol Ethers/ Ethyl Lactate:
  Because glycol ethers **emulsify well and separate easily**, they are prime candidates for the organic components of semi-aqueous solvents. They are also being substituted for both harmful halogenated hydrocarbon and high-volatility oxygenated solvents in capacities ranging from **dry cleaning to degreasing**. Often azeotropic blends and additives such as isoparaffinic hydrocarbons are supplemented in to increase the solvent's efficacy rating, work surface compatibility, and/ or decrease the solvents flammability. However, glycol ethers are **highly flammable VOC's**.

  Commercially important glycol ethers have been separated into **two categories**: the E-series, or ethylene



  glycol ethers, and P-series, or propylene glycol ethers. Because they have been linked to **miscarriages**, SARA 113 and OSHA heavily regulate the E-series. Due to these concerns, alternatives are being researched.

- n- Methylpyrrolidone (NMP):
  NMP is a **combustible VOC** listed under the SARA 113 Title III. Despite this listing, NMP is **very useful** in removing high-molecular-weight greases and carbon deposits as well as coatings (polyurethane, ink, and resin), enamels, and many plastics. It can be employed in both immersion and ultrasonic processes. Since many oils are only soluble in NMP above 145 F°, oil soils can be easily separated and the **solvent reclaimed** by lowering the solvent temperature. Furthermore, NMP is **biodegradable** and can also be reclaimed through separation and subsequent vacuum distillation.

Aromatic and aliphatic hydrocarbon solvents:

These solvents are also referred to as unsaturated hydrocarbons. Due to their flammability concerns and redox potential, aromatic and aliphatic hydrocarbon solvents share the advantages and disadvantages of the oxygenated solvents.

Alternatives that Reduce Risk

- Terpenes:

  Derived from natural sources such as citrus fruit and pine trees, terpenes are **biodegradable** and are **useful** in semi-aqueous solutions (from which they can often be **separated and reused**). Terpenes are **flammable VOC's** and very **strong cleaners**, removing resin, fingerprints, and high-molecular-weight greases. They can be used in ambient immersion and ultrasonic applications, though they may be too strong for some work surfaces.

- Petroleum Distillates:
  Produced from crude oil cracking, petroleum distillates are also **flammable VOC's** used to remove high-molecular-weight greases, tar, and waxes in immersion or manual applications. This class of solvents includes mineral and white spirits, naphtha, kerosene, and Stoddard solvent, which **vary in cost and toxicity**. Petroleum distillates are able to penetrate and clean porous surfaces, and **evaporative losses can be minimized** through the use of a parraffinic hydrocarbon additive. Furthermore, they can serve in some semi-aqueous solutions, from which they can be **easily reclaimed** through separation or distillation techniques.

Aqueous Solvents

Aqueous solvents are a category consisting mainly of **water and dissolved inorganic water soluble components** such as surfactants, chelating agents, emulsifiers, sequestering agents, and corrosion inhibitors. Water is a polar compound, meaning that a portion of the water molecule, the oxygen atom, has a greater affinity for the molecule's bonding electrons, and hence has a slight negative charge. As a result, the remaining portions of the molecule, the hydrogen atoms, have a slight positive charge. Due to this charge separation within their constituent molecules, aqueous solvents are held together by intermolecular forces in which the negatively charged oxygen atom of one water molecule creates a weak bond to the positively charged hydrogen atom of another water molecule. These intermolecular attractions, referred to as hydrogen bonding, in conjunction with its basicity/ acidity allow the **solvent to "attack" any soil** which contains charged portions.

Aqueous solvents are generally **superior to organic solvent methods**. Due to the **benign nature of water**, aqueous solvents are **less hazardous to both human and environmental health** than their organic counterparts. Aqueous solvents are **often corrosive or harmful** to work surfaces, and are often **ineffective** with porous surfaces or soils. Furthermore, due to their immiscibility with organic contaminants, aqueous solvents must be **repeatedly applied** to common organic soiling agents to achieve effective removal. Often the process requires high pressure or ultrasonic technology. Therefore, in weighing the environmental factors involved in replacing organic solvents with aqueous solvents, the **increased volume of wastewater** streams must be considered. When utilizing aqueous solvents, it is tempting to dispose of the waste solution down the drain; however, the **local water authorities** should always be consulted about proper waste disposal.

Types of Aqueous Solvents:

Alkaline aqueous solvents:

Alkaline aqueous solvents have a pH greater than 7. Adding base to an aqueous solution creates an alkaline solvent, which contains negatively charged ions. These negatively charged particles disrupt the polar bonds binding the contaminants to the work surface, as well as obstruct the intermolecular bonds holding the contaminant together, thereby **dissolving the contaminant**. Due to the **corrosive** nature of these ions, inhibitors must be added to protect metallic work surfaces, especially aluminum surfaces. With the right additives and process optimization, alkaline solvents can be utilized with all types of liquid cleansing processes. With thorough **filtration and rinsing**, very high levels of cleanliness can be achieved, although the process may become **water intensive**. Alkaline aqueous solvents are **widely applicable**, **low waste**, and **cost effective**.

Neutral Aqueous solvents:

Having a pH of approximately 7, neutral aqueous solvents are mixtures of water and above-mentioned process specific additives. **Weaker than alkaline solvents**, neutral solvents are **effective** at removing light oils, salts, particles, and soils that are easily removed. For these contaminants, the **dissolving properties** of hydrogen bonding are sufficient to break up and remove the soil. Due to their weaker activity, neutral solvents are **less widely applicable** and are most effective in spray and ultrasonic applications, especially in degreasing processes.

Acidic Aqueous solutions:

Acidic aqueous solutions have a pH less than 7 and may be comprised of mineral acids, chromic acids, or organic acids that are miscible in water due to their acidic properties. Acids have free floating positive charge, making them **excellent** at removing scale, rust, and oxidizing agents from metals. The positive portions of the acid surround and **dissolve** the aberrant negatively charged metal region. Some metal/ acid combinations cause hydrogen embrittlement on the surface of the metal. This can be significantly reduced or eliminated by changing acids or heat-treating the metal before the cleansing treatment. Because acidic aqueous solvents are less adaptable to general cleaning processes, they are **less common** as cleaning solvents.

Semi-Aqueous Solvents:

Two different types of semi-aqueous solvent procedures are commonly used. The first involves a solvent in which hydrocarbon/ surfactant cleaners are emulsified in water, meaning that the hydrocarbon/ surfactant exists as droplets suspended in the aqueous support. This arrangement combines the **more effective** contaminant dissolution and high-molecular-weight soil removal characteristics of petroleum-based solvents, with the **increased environmental safety** of aqueous methods.

The other semi-aqueous method entails an initial concentrated hydrocarbon application followed by an aqueous rinse cycle. Again, this method utilizes the **effectiveness of organic solvents** while **lessening the environmental impact** of the overall process by reducing the amount of organic solvent employed. The application techniques for both semi-aqueous methods are similar to those used in aqueous methods, though **flammability**, phase separation, and **odor problems** can arise with the mixing of the solvent types, making equipment design an important consideration.

Super Critical Fluids

Supercritical fluids are common gasses such as carbon dioxide under **extreme pressure** and **temperature**. Under these conditions, the fluid no longer exhibits the characteristics of a liquid or a gas, but rather has properties conducive to **high soil dissolution**. The high temperature of a critical fluid confers a high energy level to the individual molecules, which under atmospheric pressure would cause the molecules to increase molecular vibrations and velocity, causing the fluid to expand.

However, because critical fluids are also under high pressure, the high-energy molecules are not able to expand and must exist in a tightly packed, high-energy configuration. It is this dense, high-energy arrangement that gives critical fluids their high soil dissolution properties. This current technology combines application **flexibility** with **low cost**. However, it requires **large capital investment** to design and maintain a system capable of safely withstanding such high temperatures and pressures. **More testing** must be completed to understand the effects on sensitive work surfaces.

New Mexico Occupational Health & Safety Bureau

New Mexico Environment Department
Santa Fe, New Mexico 87502

525 Camino de los Marquez - PO Box 26110
(505) 827-4230 Fax (505) 827-4422

Jewelry Shop Safety Checklist

YES NO

General Conditions

☐ ☐ Is ventilation strong enough to remove fumes and odors from work areas?
☐ ☐ Is there good ventilation even when windows are closed on rainy or windy days?
☐ ☐ Is there a break room away from work areas? Are eating, drinking, and smoking prohibited in work areas?

Chemical Storage

☐ ☐ Do all containers have labels?
☐ ☐ Are chemicals stored in fire-resistant cabinets or rooms?
☐ ☐ Are incompatible chemicals (such as cyanide and acids) stored in separate areas?
☐ ☐ Are waste chemicals disposed of properly and promptly?

Waxing

☐ ☐ Does the waxing area have ventilation to remove paraffin fumes?
☐ ☐ Is there enough light for the detailed work done by waxers?

Casting

☐ ☐ Has a hazard assessment been conducted for metal fume exposure to determine if respiratory protection is needed? (i.e. lead, cadmium air monitoring)
☐ ☐ Are safety glasses worn while metals are being melted?
☐ ☐ Is metal kept molten for the briefest time practical to reduce metal fume exposure?
☐ ☐ Do casters wear fireproof (but asbestos free) gloves and aprons while handling hot metals?
☐ ☐ Is there ventilation in the area where metal is melted to remove metal fumes?
☐ ☐ For rotary casting machines: Is there a safety switch that prevents operation of the machine when the lid is open? Is the machine bolted securely to the floor?

Stripping and Knockout

☐ ☐ Has a hazard assessment been conducted for silica exposure?
☐ ☐ Are flasks allowed to cool for a few minutes after casting, before quenching in water?

☐ ☐ When investment is removed from the flasks, is it kept completely wet to reduce dust?
☐ ☐ Are traces of investment removed from cast trees without using hydrofluoric acid?
☐ ☐ Is this done by using: water-jet cleaning? And ultrasonic bath? Glass-bead blasting?
☐ ☐ If hydrofluoric acid is used to remove investment, are the needed safety measures taken?
☐ ☐ Are gloves and chemical goggles worn whenever the acid is handled?
☐ ☐ Are an acid proof coat, goggles, and face shield worn when concentrated hydrofluoric acid is handled?

YES NO

☐ ☐ Are gloves made of neoprene, nitrile rubber, or natural rubber?
☐ ☐ Are an emergency shower and eyewash station located within 25 feet of the concentrated hydrofluoric acid area?
☐ ☐ Has stripping been eliminated by using special gold alloys, or by glass-bead blasting of the cast trees?
☐ ☐ If stripping is needed, has bombing been replaced by a cyanide-free stripping process?
☐ ☐ If cyanide stripping is still used, are all necessary safety precautions taken?
☐ ☐ Are employees who handle cyanide trained in its hazards and in safe work practices?
☐ ☐ Are all cyanide containers clearly labeled, indicating the contents and hazards?
☐ ☐ Is the equipment used to measure and mix cyanide used for those purposes only?
☐ ☐ Is cyanide stored in a locked cabinet to prevent unauthorized use?
☐ ☐ Does the stripping area have ventilation to remove airborne cyanide?
☐ ☐ Are eating, drinking, and smoking prohibited in the stripping area?

Soldering and Finishing

☐ ☐ Is cadmium free solder used exclusively?
☐ ☐ Has a hazard assessment been conducted for cadmium exposure if solder is not cadmium free (i.e. air monitoring) to determine if respiratory protection is necessary?
☐ ☐ Has a hazard assessment been conducted for lead exposure (i.e. air monitoring) to determine if respiratory protection is necessary?
☐ ☐ Are the ingredients of all solders clearly identified on their labels?
☐ ☐ If paste solder is used, is the flux free of fluorides, such as fluoborates and zinc fluoride?
☐ ☐ Is a “safety pickle” (such a sodium bisulfate) used as a pickling agent, instead of sulfuric acid?
☐ ☐ Is the lighting strong enough, but free of glare?

Polishing

☐ ☐ Are the dust collectors on all polishing machines working effectively? Check for two warning signs that the ventilation is not working well enough.
☐ ☐ Does grit accumulate rapidly on surfaces surrounding the polishing wheels?

☐ ☐ If you leave a sheet of paper in the polishing room, does it get covered with dust in a few days?
☐ ☐ Are safety glasses or other shields always used when polishing to prevent eye injuries?
☐ ☐ Are vibratory polishers or tumblers used instead of ordinary polishing wheels where appropriate?
☐ ☐ Are the noise levels produced by tumblers below the 8 hour time weighted average of 85dBA (action level)?

Stone Setting

☐ ☐ Are stone setters encouraged to work under magnifying lenses to reduce eye-strain?
☐ ☐ Are setters given tools that can be used comfortably without placing strain on the hands or wrists?

☐ ☐ Is the lighting strong enough, but free of glare?

Machining

☐ ☐ Are safety glasses worn during all jobs that might produce flying objects? These jobs include drilling, milling, engraving, stamping, stretching, and others.
☐ ☐ Do all presses have safeguards that prevent amputation of hands or fingers? Check to see that at least one of the effective safety mechanisms is used:
☐ ☐ Are guards installed that completely prevent placement of fingers between the dies?

☐ ☐ Are there switches that must be pressed with both hands to begin operation, along with simple guarding to keep the hands clear during each operating cycle?

YES NO

☐ ☐ Are all lathe cutting tools solidly mounted on the lathe, rather than being hand-held?
☐ ☐ Do rolling mills have an automatic shut-off bar in the pinch point between the rollers?
☐ ☐ Are all drive belts and gears properly guarded?

Plating

☐ ☐ Are the contents of each plating bath clearly labeled?
☐ ☐ Are gloves and goggles worn when handling acids and other corrosive chemicals?
☐ ☐ Is an emergency shower and eyewash installed in the plating room, in case of an accident?
☐ ☐ If cyanide solutions are used for plating, are all the cyanide precautions descried in **"Stripping and Knockout"** being followed?
☐ ☐ For black plating, have solution that are free of chromium salts (which cause cancer) been tried?

Cleaning

☐ ☐ Are steam tanks inspected and certified yearly?
☐ ☐ If ammonia solution is used, is there ventilation to reduce the amount of ammonia in work areas?
☐ ☐ Are ammonia baths kept covered whenever possible?
☐ ☐ If solvents such as acetone or trichloroethane are used, is good ventilation and protective equipment provided?

Refining

☐ ☐ Have alternatives to in-house refining been considered?
☐ ☐ Are gloves, goggles, and an acid suit worn while handling corrosive chemicals?
☐ ☐ Is an emergency shower and eyewash installed in the refinery, in case of an accident?
☐ ☐ Are refinery employees trained in the use of acid-gas respirators, for protection when handling spills?
☐ ☐ Is a generous quantity of acid-resistant absorbent stored nearby, for use on acid spills?
☐ ☐ If cyanide is used, are all the cyanide precautions described in **"Stripping and Knockout"** being followed?

General Health and Safety Issues

YES **NO**

☐ ☐ Do the employees wear respirators?

If so,

☐ ☐ Does the company have a written respiratory protection program?

☐ ☐ Are employees trained to properly wear, clean/maintain, and know in what situations the respirators are needed?

If not,

☐ ☐ Is the indoor air quality such that they are not needed?

☐ ☐ Is there a written Hazard Communication Program?

☐ ☐ Are MSD sheets available for all the hazardous chemicals in the workplace and are they updated regularly?

☐ ☐ Have employees received Hazard Communication training?

☐ ☐ Are there elevated storage/equipment lofts or platforms present?

If so,

☐ ☐ Are signs showing the weight capacity present?

☐ ☐ If the floors are more than 4 feet above a lower floor, are guardrails present?

☐ ☐ Are all exits marked with signs?

☐ ☐ Are exit doors free to access and are routes to these exits kept free of obstructions?

☐ ☐ Is there a procedure in place for obtaining medical treatment for injured employees?

☐ ☐ Are there first aid supplies readily available?

☐ ☐ Are there fire extinguishers on site?

☐ ☐ Are they charged and ready for use?

☐ ☐ Are employees required to use these extinguishers?

If yes,

☐ ☐ Is the path unobstructed?

YES **NO**

☐ ☐ Are they subjected to an annual inspection?

☐ ☐ Are employees trained to use them?

If not,

☐ ☐ Is there a written policy that requires employee evacuation?

☐ ☐ Does the company have an emergency action plan and fire prevention plan?

☐ ☐ Has the electrical system throughout the facility been assessed for situations where an employee may come into contact with an electrical current, or the electrical system is such that a fire hazard exists (i.e. bare conductors, faulty equipment, exposed electrical equipment where a flammable/explosive environment may exist)?

☐ ☐ Does the employer (if 10+ employees are employed) record occupational injuries and illnesses on the OSHA-200 log?

Note: If any of the above questions that are answered with "Yes", then the condition is probably adequate. If any of the above questions are answered "NO", then re-evaluate the situation, as a violation of the standards may exist. For assistance contact:

NEW MEXICO OCCUPATIONAL HEALTH & SAFETY BUREAU
CONSULTATION PROGRAM
505-827-4230

The Consultation Program provides safety and industrial hygiene surveys of workplaces, along with evaluation of, and assistance with the establishment of safety and health programs. The program is administered by the State but is operated separately from the Enforcement Program. The services are primarily targeted to smaller businesses, both public and private. The goal is to reduce workplace injuries and illnesses by helping businesses identify workplace hazards and find effective, economical solutions for eliminating or controlling them. The service is free and there are no penalties or fines, even if problems are found. Participation in this voluntary program has helped many New Mexico Businesses lower their costs associated with worker's compensation claims and increase their efficiency and productivity.

OSHA CONSULTATION/TECHNICAL SERVICES

FREQUENTLY ASKED QUESTIONS

What is the Consultation Service all about?

The Consultation program provides safety and industrial hygiene surveys of workplaces, along with evaluation of, and assistance with establishment of safety and health programs. Although the service was established by the same Act that created the Occupational Safety and Health Administration, and the associated enforcement/compliance agencies on the federal and state level, the Consultation Service does not issue fines or penalties. Since the same regulations are covered, the service allows the employer to benefit from the professional assistance, without fines being imposed.

What does your service cost and who is eligible?

The Occupational Health & Safety Bureau (OHSB) offers consultation services free of charge to New Mexico employers with 250 or less employees on location or 500 statewide. Limited services are available to larger companies. Consultation is offered only at the request of an employer.

What types of places do you visit?

The extent of the OSHA Act is to protect employees in all places of work. These include machine shops, hospitals, offices, chemical manufacturing plants etc. The consultation program is designed to assist employers (especially small employers) in complying with the requirements of OSHA regulations. We therefore, visit any place of employment that has employees.

Where does the Consultation Service get its funding?

The program receives funding from both the federal and the state government.

How long does the consultation process take?

Depending on the size of the company and the scope of the visit, a consultation may take anywhere from one or two hours to a full day. If exposure monitoring is requested or recommended, another day is often scheduled.

What kinds of things do you look at?

In order to evaluate the systems in place, sufficient information from the employer may be needed. This would include assessing existing safety and health programs, the OSHA 200 logs, accident investigation reports, and a walk-through of the facility to identify potential injury and illness hazards in the workplace.

Do we have to let you in all areas?

You, the employer makes that determination. If you requested a comprehensive survey, the consultant will look at all areas.

Can it be arranged for both the safety and the industrial hygiene visits to be conducted on the same day?

Visits are scheduled based on the caseload of the consultants. Where the caseloads permit such an arrangement can be made.

Do I (the employer) have to fix everything you find?

The employer is obligated to correct all serious hazards found by the consultant, within a reasonable time frame. Time extensions are granted for abatement of hazards when needed, if the employer is providing interim protection for employees.

How are hazards classified as “serious” & “other than serious”?

A serious violation results where there is substantial probability that death or serious physical harm could result. An other than serious violation is a hazard that has a direct relationship to job safety and health, but probably would not cause death or serious physical harm.

How much will it cost to correct/fix the hazards identified?

Usually, it is not prohibitively costly to correct hazards identified by our consultants.
However, where cost becomes an overriding consideration or where the employer can show that engineering controls are not feasible the employer may seek a variance from OHSB. In this case the employer must show that a combination of work practices, administrative controls, and personal protective equipment will provide equal or better protection for the employees.

Do you come back to verify hazard correction?

For regular consultation visits, a statement of assurance of correction for each hazard is usually acceptable. For special program consultations (SHARP) a follow-up visit is usually conducted to verify correction of hazards.

How do we request an extension of time on corrections?

All extensions have to be requested in writing. The letter should include the reason for the extension, what has been done to date to correct hazards; and if corrections have not been made, the employer must state what interim measures have been taken to protect the employees.

What is the SHARP Program all about?

SHARP or Safety and Health Achievement Recognition Program is one of our special programs for companies wishing to go the extra mile to establish a fully functional overall safety and health program, in addition to the correction of hazards. SHARP is primarily a recognition program for exemplary companies, but an added incentive for SHARP participants is a one-year exemption from OHSB's general schedule inspections.

Does Sharp keep OHSB enforcement out in all cases?

No, At SHARP sites, OHSB will continue to make inspections in the following situations:

- imminent danger;
- fatality/catastrophe;
- formal complaints;
- referral from other government agencies; or
- follow-up on previously cited violations.

Where can I get information on establishing written programs (i.e. blood borne pathogen, hazard communication, confined space, etc?

Many of the safety and health programs are available through the New Mexico Occupational Health & Safety Consultation Program. They are available upon request.

How do we know which elements of the safety and health program requirements need to be fixed, if it doesn't show up on your report to us?

It is addressed in the safety & health program management section of the report the employer receives. These issues are also discussed by the consultant with the employer.

Is it necessary to have a written certification of hazard assessment at work sites that do not require (PPE) Personal Protective Equipment for any task?

Yes, according to 1910.132(d)(2), the employer shall verify that the required workplace hazard assessment has been performed through a written certification that identifies the workplace evaluated.

Can you come to our company and conduct a class or safety meeting?

Onsite training and education by consultants will be based on available resources and the employers request. The training and education will be tailored to the nature of the hazards or potential hazards in each specific workplace. Training in specific areas is also available through private consultants and the New Mexico Workers Compensation Administration or your insurer.

Can the consultant come back for specific things such as checking new equipment or processes that we bring on line?

Yes, Visits for specific purposes can be requested, in addition to regular consultation visits.

May I call your office anytime to ask questions?

Consultants are available to answer questions between 7-5pm Monday-Friday

Can anyone gain access to my report?

No, our files are confidential and are destroyed after 3 years.

Will a consultation visit lead to an inspection by OSHA compliance? Will your findings be passed on them?

All information is kept confidential. OHSB compliance inspectors cannot discover where we have been and then inspect those companies. The only time enforcement is contacted, is if a company neglects to correct serious hazards beyond time extensions. Then we are obligated to refer those items to enforcement, but only after we have made every attempt to work with the company.

What determines when a compliance inspection is going to occur? How do they decide whom they are going to visit?

Factors that may trigger a compliance inspections include:

- formal complaints by employees or their authorized agents;
- fatalities;
- catastrophe or major incidents;
- history of the company (previous OSHA activity);
- referral by other governmental agencies;
- general schedule inspections; or
- special emphasis programs

Have you been or will you go to my competitor?

Our service extends to all eligible companies who request it. All information is kept confidential; therefore, no hazards, or processes that may be a trade secret, seen in your facility will be discussed in another place of business.

Where can I get a copy of the regulations?

The Government Printing Office (GPO) processes all sales and distribution of the CFR. For payment by credit card, call (202) 512-1800, M-F, 8am to 4 pm or fax your order to (202) 512-2250, 24 hours a day. For payment by check, write to the Superintendent of Documents, Attn: New Orders, PO Box 371954, Pittsburgh, PA 15250-7954. Regulations and other material are available on the Internet at www.osha.gov.